COMMENTS OF THE AMERICAN FARM BUREAU FEDERATION, DESERET POWER ELECTRIC COOPERATIVE AND SUNFLOWER ELECTRIC POWER CORPORATION ON EPA'S PROPOSED ENDANGERMENT FINDING

Docket ID No. EPA–HQ–OAR–2009–0171

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I. INTRODUCTION.

A. Overview.

The American Farm Bureau Federation, Deseret Power Electric Cooperative and Sunflower Electric Power Corporation ("Commenters") submit these comments on *Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act; Proposed Rule*, 74 Fed. Reg. 16448 (Apr. 10, 2009) (hereafter "Endangerment Finding Proposal"). Commenters believe that the Endangerment Finding Proposal, including the attached Technical Support Document ("TSD"), presents an incomplete discussion of climate change science. The Environmental Protection Agency ("EPA" or "Agency") has ignored literally hundreds of peer-reviewed scientific articles that are at odds with major portions of EPA's conclusions.[1] These studies were also not accounted for in the reports of the United Nations International Panel on Climate Change ("IPCC") and the United States Climate Change Science Program ("CCSP") on which EPA heavily relies.

These studies call into question EPA's basic conclusion that GHG emissions from new motor vehicles (and, by implication, from a wide array of human sources) cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. The studies show that the General Circulation Models ("GCMs") on which the IPCC and CCSP, and therefore EPA, rely fail fundamentally to simulate the known climate and therefore are not reliable for predicting the climate future. These studies further show that current global

[1] For convenience, the portion of the Endangerment Finding Proposal that appeared in the Federal Register without the TSD is referred to in citations below as "EF."

temperatures and "extreme" climate events that EPA says are outside the range of natural variability have, in fact, occurred with some frequency in the past before atmospheric greenhouse gas concentrations began to reflect a human influence. Finally, these studies provide alternative explanations for current climatological conditions that EPA attributes to anthropogenic greenhouse gas emissions (GHGs) emissions.

Commenters' views in this regard are supported by two detailed literature reviews that were conducted for us by scientists who routinely publish on climatology in peer-reviewed scientific journals. These reviews are attached and provide a point-by-point discussion of the Endangerment Finding Proposal and TSD, setting forth the peer-reviewed science that neither EPA nor the IPCC or CCSP reports discuss and that contradict EPA's conclusions.[2]

The point of Commenters' analysis is not to demonstrate that EPA's view of the science is wrong. It may well be that, upon reviewing all the scientific literature, EPA could find that GHGs from new motor vehicles "cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare," within the meaning of Section 202(a) of the Clean Air Act ("CAA"). ***Indeed, for purposes of these comments, we expressly do not take a position that GHG emissions either do or do not present an endangerment threat, nor do we take a position that regulation of GHGs is or is not justified.***

We do maintain, however, that EPA may not, consistent with its responsibilities under Section 202(a), make an Endangerment Finding without providing a considerably more comprehensive and balanced scientific discussion. Absent such discussion, EPA's Endangerment Finding will be arbitrary and capricious, contrary to the letter and spirit of the

[2] The two reviews are "Endangerment Finding Literature Review" conducted by Dr. Craig Idso, Chairman of the Center for the Study of Carbon Dioxide and Global Change, and "Endangerment Finding Literature Review" conducted by Professor Patrick Michaels of the University of Virginia. These two literature reviews are referred to herein as "Idso" and "Michaels."

Information Quality Act, and a failure by the Administrator to exercise independent judgment as required by Section 202(a).

Commenters, therefore, ask that EPA fundamentally reexamine its scientific analysis in light of the science we present here. If, upon such reanalysis, the Agency continues to believe that the science justifies an Endangerment Finding, the Agency should reissue such a finding in proposed form and solicit further public comment. A new comment period is justified both by the severity of the Endangerment Finding Proposal's failure to comprehensively address climate change science and the overwhelming public importance of the subject matter.

B. Issue Too Important for Rush to Judgment.

Commenters believe that EPA's incomplete analysis may have been the result of a rush-to-judgment on the part of the Administrator. Although Section 202(a) requires that an Endangerment Finding must reflect the Administrator's own judgment, the Proposal was issued less than three months after the Administrator took office and before the Deputy Administrator, the General Counsel, and the Assistant Administrator for Air and Radiation, who should have been among her principal advisors on this subject, had been confirmed. Given the enormity of the subject matter, more time should have been taken. As set forth in EPA's own information quality guidelines, "EPA recognizes that influential scientific … information should be subject to a higher degree of quality … than information that may not have a clear and substantial impact on important public policies or private sector decisions." *See Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency*, EPA/260R-02-008 (Oct. 2002) (hereafter "EPA Information Quality Guidelines"). The Administrator just last month, in passing on to staff the new President's "Memorandum on Scientific Integrity," emphasized that "the Agency's scientific

processes [would] meet the highest standards of rigor, quality, and integrity." *See* Memo to EPA Employees, May 9, 2009, available at http://www.epa.gov/administrator/scientificmemo.html. Yet in one of the Administrator's first exercises of scientific judgment – her proposed Endangerment Finding here – she has issued a document that does not consider a considerable body of scientific research, that accepts the work of the IPCC and CCSP without considering other scientific views, and that allows the public only sixty days to dispute this view of the science.

The Administrator's hasty judgment is not justified by the fact that EPA considered this matter in the previous Administration in the ANPR (*Regulating Greenhouse Gas Emissions under the Clean Air Act, Advance Notice of Proposed Rulemaking*, 73 Fed. Reg. 44354 (Jul. 30, 2008)). That docket generated among the largest set of comments ever received by an Agency proceeding, including numerous and detailed comments on the science. It is difficult to believe that the Administrator gave those comments careful consideration in the limited time frame in which she acted here.

Indeed, the need for further analysis by EPA is highlighted by EPA's failure in many cases to respond to the detailed science comments that were submitted on the ANPR. Although the TSD references a limited number of such comments, evidently there was insufficient time for the Administrator to give them full consideration. The problem here is magnified by the Endangerment Finding Proposal's near total reliance on the Fourth Assessment Report of the IPCC and the CCSP reports. As several commenters in the ANPR docket noted as to EPA's science TSD in that docket, climate change science is developing very quickly, yet the IPCC Fourth Assessment Report did not utilize science produced after early 2006. The Endangerment Finding Proposal recognizes this fact, and cites *some* papers authored thereafter, but again fails

to comprehensively discuss findings in recent papers that are contrary to EPA's conclusions. ***We count at least 43 significant peer-reviewed papers published too late for inclusion in either the IPCC Fourth Assessment Report or the CCSP reports that were not discussed in EPA's TSD and which tend to undercut EPA's conclusions.*** *See* Michaels at 29.

EPA's rush to issue the Endangerment Finding Proposal is inexplicable given that EPA has not even published the proposed regulations that a final Endangerment Finding would trigger. As EPA states, "[t]ypically, the endangerment and cause or contribute findings have been proposed concurrently with proposed standards under various sections of the CAA." 74 Fed. Reg. at 18888/3. In fact, to our knowledge, EPA has never proposed an Endangerment Finding without also proposing regulations. Given the fact that EPA does not yet have regulatory proposals ready, it had no need to act with such haste.

For that reason, EPA's insistence on a sixty-day comment deadline is wholly unjustified. The fact that the sixty-day comment period substantially overlapped with the comment period for EPA's GHG reporting rule and completely overlapped with Congress' consideration of GHG legislation has seriously compromised our ability to provide a detailed analysis of the numerous climate science issues discussed in the Endangerment Finding Proposal, raises fundamental fairness and due process issues, and undermines the efficacy of the public comment process.

The far-ranging effect of an Endangerment Finding makes a more deliberate approach all the more critical. Although an Endangerment Finding in the present docket technically applies only to new motor vehicles and new motor vehicle engines under Section 202(a), EPA is well aware that the precedent set by an Endangerment Finding here will have enormous consequences throughout the economy under other CAA programs. As EPA noted in the ANPR preamble, the Endangerment Finding language in Section 202(a) is very similar to Endangerment Finding

provisions in other CAA provisions that are applicable to both stationary and other mobile sources. Hence, an Endangerment Finding in the context of Section 202(a) will inevitably result in similar Endangerment Findings under these other provisions for other sources, as it cannot seriously be argued that new motor vehicle GHG emissions endanger public health or welfare but GHG emissions from other significant sources do not.

Moreover, EPA believes that an Endangerment Finding in this docket will trigger a legally binding obligation to regulate under Section 202(a), and that an Endangerment Finding under other CAA provisions will trigger an obligation to regulate under those provisions as well. The ANPR sets forth a daunting list of potential regulatory programs affecting almost every corner of the economy that could be triggered if EPA concludes that GHG emissions endanger public health or welfare. Indeed, as EPA is well aware, a number of environmental parties believe that simply finalizing the Endangerment Finding will confirm their view that CO_2 is a regulated pollutant for purposes of the New Source Review/Prevention of Significant Deterioration programs, potentially triggering extremely large consequences for sources with the potential to emit at least 250 tons per year of that substance.

An Endangerment Finding will have such vast consequences because, as the IPCC has noted, "[e]missions of GHGs are associated with an extraordinary array of human activities." IPCC, *Climate Change 2001*: *Mitigation* ("IPCC 2001"), at 608, *available at* http://www.ipcc.ch/. This is because the nation and the world run on fossil fuel, with 85 percent of domestic energy being fossil fuel-based, and because CO_2 is the inevitable byproduct of the combustion of fossil fuels. As EPA stated in the ANPR, "[v]irtually every sector of the U.S. economy is either directly or indirectly a source of GHG emissions." 68 Fed. Reg. at 52,928.

C. Key Evidence Unaddressed in EPA Analysis.

The extreme importance of an Endangerment Finding should have led EPA to provide a particularly searching discussion of the peer-reviewed scientific literature that might disagree with EPA's conclusions. Yet EPA missed critical scientific information that undermines EPA's conclusions on issues that are central to the endangerment question. We provide a detailed discussion below of the missing science, and the attached studies provide an even more detailed analysis. For purposes of this Introduction, we will focus on several of the most important issues.

EPA's Endangerment Finding Proposal rests on the following conclusions. First, relying on the work of the IPCC and on the GCMs that form the basis of the IPCC conclusions, EPA concludes that the current warming trend and what EPA describes as extreme weather events can only be explained by anthropogenic GHG emissions. EPA states that global surface temperatures have risen by 0.74°C ±0.18°C between 1906 and 2005, with eight of the ten warmest years occurring since 2001. EPA states that this warming in the last one hundred years was separated into two periods, one occurring prior to the 1940s (which preceded the major buildup of atmospheric GHGs), and the other occurring at a higher rate after the mid-1970s, with a cooling period in between. EPA states that it can be said "with a high degree of confidence" that global mean surface temperatures were higher during the last few decades of the 20th Century than any comparable period during the preceding four centuries. Although expressing less confidence in the conclusion, EPA states that temperatures today are generally higher than at any time since A.D. 900. TSD at 22-26.

According to EPA, "[m]ost of the observed increase in global average temperatures since the mid-20th Century is very likely due to the observed increase in anthropogenic observations."

TSD at ES-2. EPA's conclusion that recent warming may be attributed to anthropogenic GHG emissions relies primarily on the fact that "[c]limate model simulations suggest natural forcing alone (e.g., changes in solar irradiance) cannot explain the observed warming." *Id.* EPA also states that the current warming is occurring in a manner that is consistent with GCM predictions of anthropogenic warming (the warming has the "fingerprint" of anthropogenic warming predicted by the models). *Id.*, § 5(a). EPA further states that the climate is experiencing extreme weather events and conditions – heat waves, melting sea ice, rising sea levels, and others – that EPA believes are outside the range of natural variability and can only be explained by anthropogenic warming. *Id.* at 35.

Finally, EPA believes that the current climate, as affected by anthropogenic GHG emissions, is causing detrimental health and welfare impacts. Relying on the work of the CCSP, which in turn relied heavily on GCM model predictions at a regional level, EPA states that these detrimental health and welfare trends will continue and intensify in the future. *Id.* at ES-4.

EPA's analysis, however, flatly ignores scientific research that conflicts with EPA's conclusions on a number of key issues, as discussed more fully below and in the two attached reports.

First, how unprecedented are current temperatures?

EPA does not discuss:

- Numerous studies from peer-reviewed literature showing that the Earth was as warm or warmer during the Medieval Warm Period (roughly A.D. 900-1100) as compared to today, which would seem to undermine the notion that the current warm temperature period is almost certainly the result of human activity. Moreover, the fact that current temperatures are warmer today than at any time in the last four centuries reflects only the fact that, following the Medieval Warm Period, the Earth entered into the Little Ice Age, a period that ended shortly before the beginning of the 100-year warming trend that EPA has identified. *See* Section II.C.2 below.

- Numerous studies showing that in the current interglacial period, referred to as the Holocene, which has lasted for about 12,000 years, the Earth has experienced a number of periods in which temperatures significantly exceeded today's temperatures. *See id*.

- Numerous studies showing that across geological time, when atmospheric CO_2 concentrations and temperatures varied widely, reaching much higher levels than today, no association can be found between higher CO_2 and higher temperatures, although periods existed where rising temperature was ***followed*** thousands of years later by rising CO_2. *See* Section II.C.1 below.

Second, is the recent warming as rapid as EPA believes?

EPA does not discuss

- Thompson *et al*. (2008),[3] which noted that the drop in global surface temperatures that begin in the 1940s is apparently an artifact of an adjustment of measurements of sea-surface temperatures. Compensating for this makes the beginning of the last period warmer than thought, reducing the warming trend in the latter half of the 20th Century from 0.11°C to 0.06°C. This is in line with prior warming in the early 20th Century which occurred at a time of lower GHG concentrations and which is unlikely to have had a largely anthropogenic cause. *See* Section II.B.1.a below.

- A large number of studies showing that the 20th Century warming trend may be overstated because of data flaws, including failure to properly account for the urban heat island effect, data contamination issues and studies such as McKitrick and Michaels (2007), which found a non-urban (in their parlance, a "socioeconomic") bias of +0.04°C per decade (beginning in 1979), as a result of land use, geography, and variables pertaining to data quality. This further reduces the temperature trend in the last fifty years. EPA similarly provides an incomplete discussion of the contribution of the sun and black carbon to recent warming. *See* Section II.B.1.a-d below.

Third, is the current warming occurring in the manner predicted by GCMs?

EPA does not discuss or arbitrarily dismisses:

- Recent data showing that temperatures have been ***declining*** since 2001. Taking into account the El Nino/La Nina uptick/downtick of 1997-2001 demonstrates that ***the trend towards warming effectively stopped in 1997. This cooling trend was not predicted by any model.*** *See* Section II.B.2 below.

- Other evidence that the climate is not warming as predicted by the GCMs. *See* Section II.B.3 below.

[3] Full citations to studies referred to in these comments are included in the attached Michaels and Idso papers.

- Numerous studies showing that the Antarctic is not experiencing warming and is experiencing an expansion in sea ice. *See* Section II.B.4 below.

- Douglass *et al* (2007), refuting evidence relied on by EPA of an anthropogenic warming "fingerprint" in the vertical structure of the atmosphere. All climate models show that if GHGs are driving climate change, there will be a unique "fingerprint" in the form of a warming trend increasing with altitude in the tropical troposphere, the portion of the atmosphere up to about 15 kilometers. Satellite and weather balloon data, however, show no such association in the tropics. *See* Section II.B.5 below.

- Studies showing that, contrary to model predictions, the ocean has recently ceased accumulating heat. *See* Section II.B.6 below.

Fourth, has the climate experienced increased extremes outside the range of natural variability, indicative of an anthropogenic signal?

EPA ignores:

- Data showing that the Earth and the U.S. have experienced periods of much greater extreme weather than has occurred during the last fifty years, making it very difficult to say that increased atmospheric GHG concentrations are the cause of any particular recent weather events or variations. *See* Section II.C below.

- Data in the CCSP and other studies showing that over the long-term U.S. hurricane landfalls have been declining; nationwide there have been no long-term increases in drought; despite increases in some measures of precipitation, there have not been corresponding increases in peak streamflows (high flows above 90th percentile); there have been no observed changes in the occurrence of tornadoes or thunderstorms; there have been no long-term increases in strong East Coast winter storms, called Nor'easters; and there are no long-term trends in either heat waves or cold spells, though there are trends within shorter time periods in the overall record. *See id.*

- Studies showing that recent hurricane activity is not outside the range of multidecadal fluctuations in the strength or number of hurricanes. *See* Section II.C.4.c below.

Fifth, may an anthropogenic signal be detected from temperature and ice conditions in the Arctic and Greenland, and in sea levels?

The TSD notes that model simulations predict warming temperatures and melting sea ice in the Arctic, and EPA points to melting ice in the Arctic as key evidence supporting its view that anthropogenic GHG emissions are responsible for climate change effects. EPA also points to what it describes as an acceleration in the rate of sea level rise as further evidence to this

effect. In addition to not discussing the ***increasing*** sea ice in the Antarctic, EPA does not discuss:

- The recent increases in Arctic temperatures and ice melt have been exceeded during the current interglacial period on several occasions, with temperatures being 1°C higher than today in the Medieval warm period, and 2.5°C warmer than during the Climatic Optimum of 4,000-7,000 years ago, making it very difficult to ascribe today's Arctic conditions to the rise in atmospheric GHG concentrations. *See* Section II.C.3 below.

- Data showing that, contrary to EPA's conclusion and model predictions, the rise in sea levels that began in the 19th Century, before the significant accumulation of GHGs in the atmosphere, has not accelerated recently as atmospheric GHG concentrations increased. *See* Section II.C.5 below.

- **Sixth, has warming already caused deleterious health and welfare effects?**

EPA believes that changing climate has already damaged American health and welfare, but it again ignores important evidence to the contrary. In particular, it would appear irrefutable that, whatever the warming trend was in the 20th Century, both American and worldwide health and welfare improved dramatically. Perhaps the most direct evidence of health and welfare is mortality rates, and these of course improved significantly in the U.S. over the last 100 years:

U.S. Mortality Rate **U.S. Temperature History**

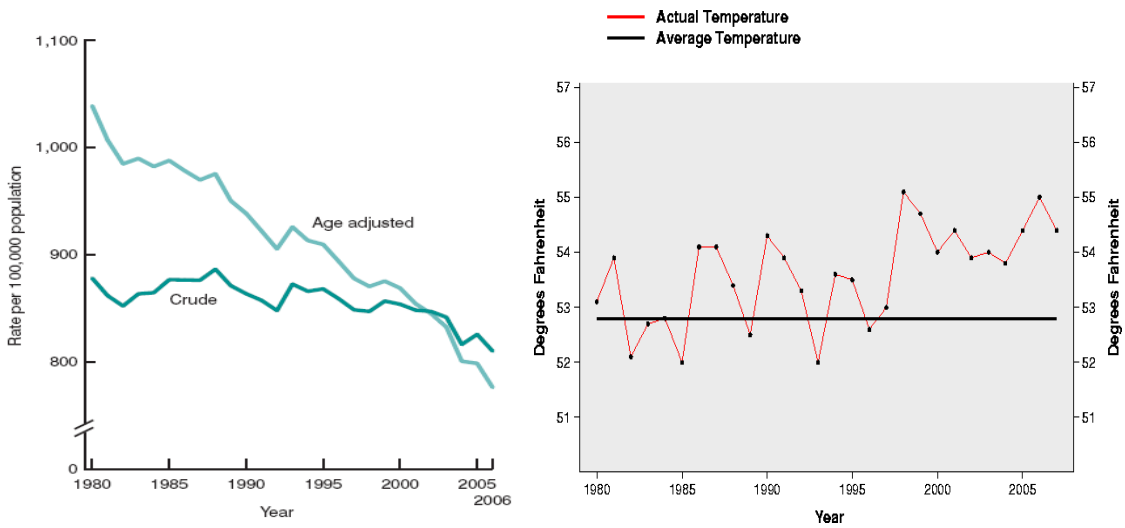


Figure 20. Left: Crude and Age-adjusted mortality rates (per 100,000 people) in the U.S. from 1980-2006 (figure source: Centers for Disease Control, http://www.cdc.gov/nchs/data/nvsr/nvsr56/nvsr56_16.pdf*). Right: U.S. average annual temperature, 1980-2008 (figure source: National Climatic Data Center, http://climvis.ncdc.noaa.gov/cgi-bin/cag3/hr-display3.pl)*

Seventh, will projected climate change affect public health and welfare in the future?

EPA projects significant negative effects as a result of a changing climate world. However:

- These projections critically depend on the accuracy of EPA's forecasts as to the climate sensitivity for a doubling of CO_2; obviously, if temperatures increase significantly less than EPA projects, the impacts on health and welfare will be lower. In this regard, EPA fails to cite critical evidence showing that temperature increases resulting from increasing CO_2 are highly likely to fall at or below the low end of EPA's projections. *See* Section II.D.1 below.

- The lead author of the Fourth IPCC Report on which EPA relies so heavily specifically disclaimed the ability of GCMs to predict regional climate. According to Kevin Trenberth, "None of the models used by IPCC are initialized to the observed state and none of the climate states in the models correspond even remotely to the current observed climate. I postulate that regional climate change is impossible to deal with properly unless the models are initialized." *Trenberth, K.E. (2007). Predictions of climate. Climate Feedback: The Climate Change Blog,*

Nature.com, June 4. Available at http://blogs.nature.com/climatefeedback/2007/06/predictions_of_climate.html.

- EPA deliberately disregards the ability of the United States to prevent negative health and welfare climate impacts through adaptation, arguing that the possible necessity to adapt is itself proof of deleterious climate change. EPA's argument, however, is illogical. The Agency's projections of future climate change are based on very long-term emissions scenarios that are based on very long-term projections of future economic activity. Economic activity therefore cannot be separated from climate change and climate impacts. How people behave in an economic setting will equally determine both the extent of any human-induced climate change and whether people are harmed by such climate change. The two issues cannot be separated. *See* Section II.D.2 below.

In sum, as stated, we do not maintain that the material that EPA missed would have inevitably led the Agency to find that GHG emissions do not endanger public health or welfare. EPA is, of course, free to make an Endangerment Finding, and a proper consideration of all the evidence might convince it to make such a finding. We do maintain, however, that EPA's Endangerment Finding Proposal analysis is rushed and incomplete and must be reexamined in light of *all* of the scientific evidence.

II. EPA's Failure to Address a Large Body of Scientific Evidence that Undermines its Conclusions Is Arbitrary and Capricious, Violates the Information Quality Act, and Represents a Failure by the Administrator to Exercise Her Own Judgment in Making an Endangerment Finding.

A. Legal Standards.

1. Arbitrary and Capricious Standard.

An EPA Endangerment Finding will be subject to scrutiny under the arbitrary and capricious standard. *See* Section 307(d)(9)(a) of the CAA. Although the arbitrary and capricious standard is a deferential one, *Marsh v. Or. Natural Res. Council*, 490 U.S. 360, 378 (1989), that deference is not absolute. *See American Farm Bureau Fed'n v. EPA*, 559 F.3d 512, 519 (D.C. Cir. 2009) (citations omitted) (a court will review EPA's actions to ensure it has "'examined the relevant data and has articulated an adequate explanation for its action.'"). A court must conduct

a "searching and careful" review of the record to establish that the agency's action was rational and based on adequate consideration of all relevant factors. *Citizens to Preserve Overton Park v. Volpe*, 401 U.S. 402, 416 (1971); *Am. Trucking Ass'ns v. EPA*, 283 F.3d 355, 362 (D.C. Cir. 2002).

EPA is legally required to consider all relevant studies presented in the record. *See American Petroleum Institute v. Costle*, 665 F.2d 1176, 1187 (D.C. Cir. 1981) (emphasis added) ("NRDC argues that the Administrator erred in setting a primary standard that does not protect sensitive individuals against easily predicted risks. In so arguing NRDC essentially ignores the mixed results of the medical studies evident in the record, choosing instead to rely only on the studies that favor its position. The Administrator, however, *was required to take into account all the relevant studies revealed in the record*"). In considering all evidence in the record, EPA must consider industry evidence as well as its own experts' evidence. *Mich. v. EPA*, 213 F.3d 663, 683 (D.C. Cir. 2000) (citing *Chemical Mfrs. Ass'n v. EPA*, 859 F.2d 977, 989 (D.C. Cir. 1988)).

Thus, while a court will not judge the merits of competing expert views, *Am. Trucking Ass'ns*, 283 F.3d at 362, it will ensure that EPA did not dismiss significant comments, criticisms or studies without adequately demonstrating that it has considered them and explaining why it disagrees with them. *Alliance to Save the Mattaponi v. U.S. Army Corps of Engineers*, No. 1:06-cv-01268-HHK, slip op. at 8 (D.D.C. March 31, 2009); *see also Prof'l Pilots Fed'n v. FAA*, 118 F.3d 758, 763 (D.C. Cir. 1997) (the agency has the burden of showing "that it afforded adequate consideration to every reasonable alternative presented for its consideration"); *Int'l Fabricare Inst. v. EPA*, 972 F.2d 384, 389 (D.C. Cir. 1992) ("Despite this deferential standard, we must ensure that EPA has examined the relevant data and has articulated an adequate explanation for

its action"). "Significant comments" are those "'which, if true, raise points relevant to the agency's decision and which, if adopted, would require a change in an agency's proposed rule.'" *City of Portland v. EPA*, 507 F.3d 706, 715 (D.C. Cir. 2007) (citations omitted).

In fact, a court will "overturn a rulemaking as arbitrary and capricious where EPA has failed to respond to specific challenges that are sufficiently central to its decision." *Int'l Fabricare Inst.*, 972 F.2d at 389; *see also American Farm Bureau Fed'n*, 559 F.3d at 520 (finding that EPA did not adequately explain why it did not examine any studies of short term exposure, and stating, "[a]n agency's failure adequately to consider a relevant and significant aspect of a problem may render its rulemaking arbitrary and capricious").

EPA was recently reminded in *American Farm Bureau Fed'n* that its deference in considering scientific evidence is not absolute. The U.S. Court of Appeals for the District of Columbia Circuit rejected EPA's not-adequately-explained decision to rely exclusively upon a particular type of study (studies of long-term exposure to particulate matter) while ignoring other studies (studies of short-term exposure to particulate matter):

> An agency's failure adequately to consider a relevant and significant aspect of a problem may render its rulemaking arbitrary and capricious. In setting the primary annual NAAQS for PM[2.5], the EPA relied exclusively upon studies of long-term exposure, placing the greatest weight upon the Harvard Six Cities and the American Cancer Society (ACS) studies. The state and environmental petitioners argue the EPA did not adequately explain why, even if the studies of long-term exposure were "most directly relevant" to setting the annual standard, the studies of short-term exposure were not at all relevant.
>
> In the EPA's view, studies of long-term exposure are most directly relevant to the annual standard because the human body responds differently to long-term than to short-term exposure and because a long-term study evaluates "periods of exposure" closer to a year than the periods evaluated in a short-term study. Be that as it may, the EPA did not assert that short-term studies provide no relevant information. The EPA concluded merely that it would be "more appropriate to consider the short-term exposure studies as a basis for . . . the 24-hour standard and to consider the long-term exposure studies as a basis for the . . . annual standard."

> . . .
> We conclude the EPA failed adequately to explain its first premise, viz. that an annual standard could be "appropriately . . . evaluated based" solely upon long-term studies. . . . If, however, the EPA can adequately explain why studies of short-term effects are not relevant to setting an annual standard, then it may disregard those studies regardless whether the short-term studies are based upon a more representative cohort than is the ACS Study.

559 F.3d at 520, 522 (citations omitted). The court remanded the annual particulate matter standard to EPA for further consideration. *Id*. at 524.

In the same vein, although EPA has "undoubted power to use predictive models," a court will reverse an agency decision relying on such models as arbitrary and capricious unless the agency "explain[s] the assumptions and methodology used in preparing the model" and "provides a complete analytic defense should the model be challenged." *Appalachian Power Co. v. EPA*, 249 F.3d 1032, 1052 (D.C. Cir. 2001) (internal quotations omitted); *Eagle-Pitcher Industries, Inc. v. EPA*, 759 F.2d 905, 921 (D.C. Cir. 1985); *Small Refiner Lead Phase-down Task Force v. EPA*, 705 F.2d 506, 535 (D.C. Cir. 1983). Moreover, "when the model bears no rational relationship to the characteristics of the data to which it is applied that we will hold that the use of the model was arbitrary and capricious." *Appalachian Power Co. v. EPA*, 249 F.3d 1032 (D.C. Cir. 2001), citing *Appalachian Power Co. v. EPA*, 135 F.3d 791, 802 (D.C. Cir. 1998).

In sum, as discussed in more detail below, EPA must provide a more complete discussion of global warming science, including particularly studies that do not support its conclusions, and it must explain why it may rely so extensively on the results of the GCMs given the well-documented inability of those models to simulate climate. Failure to do so exposes the Endangerment Finding, and any regulation that is promulgated based on the Endangerment Finding, to reversal under the arbitrary and capricious standard.

2. Information Quality Act.

EPA's analysis violates both the spirit and letter of the Information Quality Act. Enacted as Section 515 of the Consolidated Appropriations Act, 2001 (Pub.L. 106-554), the Information Quality Act directed the Director of the Office of Management and Budget (OMB) to issue guidelines ensuring and maximizing the quality, objectivity, utility and integrity of information disseminated by the agency and to require certain agenices, including EPA, to do the same. OMB's guidelines are set forth in *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies; Notice; Republication*, 67 Fed. Reg. 8452 (Feb. 22, 2002). EPA issued its own Information Quality Guidelines in October 2002. Both OMB's and EPA's Guidelines set forth requirements for the Utility and Quality of information that the Endangerment Finding Proposal fails to meet.

The OMB Guidelines define ''Utility'' as "the usefulness of the information to its intended users, including the public. In assessing the usefulness of information that the agency disseminates to the public, the agency *needs to consider the uses of the information* not only from the perspective of the agency but also from the perspective of the public." 67 Fed. Reg. at 8459/1-2 (emphasis supplied). EPA's Information Quality Guidelines amplified this requirement by providing that the Agency would subject "influential" scientific information to a "rigorous standard of quality." EPA Information Quality Guidelines at 20. "Influential" information is defined to include the following:

> Information disseminated in support of top Agency actions (i.e., rules, substantive notices, policy documents, studies, guidance) that demand the ongoing involvement of the Administrator's Office and extensive cross-Agency involvement; issues that have the potential to result in major cross-Agency or cross-media policies, are highly controversial, or provide a significant opportunity to advance the Administrator's priorities. Top Agency actions usually have potentially great or widespread impacts on the

> private sector, the public or state, local or tribal governments. This category may also include precedent-setting or controversial scientific or economic issues.

Id.

According to EPA's Guidelines, EPA must "ensure and maximize the quality of 'Influential' scientific risk assessment information" by, among other things, discussing "peer-reviewed studies known to the Administrator that support, are directly relevant to, *or fail to support any estimate of risk and the methodology used to reconcile inconsistencies in the scientific data*." *Id*. at 22-23 (emphasis supplied).

OMB's regulations define "Quality" to include "Objectivity," and defined Objectivity to include:

> whether disseminated information is being presented in an accurate, clear, complete, and unbiased manner. *This involves whether the information is presented within a proper context. Sometimes, in disseminating certain types of information to the public, other information must also be disseminated in order to ensure an accurate, clear, complete, and unbiased presentation.*

67 Fed. Reg. at 8459/3 (emphasis supplied). According to EPA, although peer-review information may generally be presumed to satisfy Objectivity requirements, "this presumption of objectivity is rebuttable."

The one-sided presentation of information in the Endangerment Finding Proposal and EPA's reliance on GCMs that have significant forecast flaws are not consistent with these Utility and Quality criteria. Plainly, the Endangerment Finding Proposal qualifies as "influential" scientific information within the meaning of EPA's guidelines, since an Endangerment Finding will trigger GHG regulation of automobiles, PSD/NSR requirements for all major stationary sources, and likely other far-reaching regulation. It therefore satisfies all of EPA's criteria for influential scientific information: it has "required involvement of the Administrator's Office and

extensive cross-Agency involvement" and the issues "have the potential to result in major cross-Agency or cross-media policies, are highly controversial, [and have] provide[d] a significant opportunity to advance the Administrator's priorities." Moreover, an Endangerment Finding will "have potentially great or widespread impacts on the private sector, the public or state, local or tribal governments." The action will also "include precedent-setting or controversial scientific or economic issues."

As a result, EPA should have, but failed to, apply a "rigorous standard of quality," including a discussion of peer-reviewed studies that may contradict the Administrator's conclusions. Such a balanced discussion, for the reasons set forth below, is lacking in the Endangerment Finding Proposal.

For the same reason, EPA's analysis fails the Objectivity requirement. As discussed below, EPA's discussion did not include a proper context of other peer-reviewed studies that conflict with EPA's conclusions.

3. Administrator Required to Exercise Her Own Judgment.

Section 202(a) is crystal clear that the EPA Administrator is obligated to exercise her own judgment in deciding whether or not to make an endangerment finding. She may, of course, consistent with Section 202(a), rely on the IPCC and CCSP reports if, ***based on her own analysis***, she decides that those reports present a comprehensive and persuasive view of the science. The fact that the Endangerment Finding Proposal does not even attempt to address the large body of information that contradicts the conclusions she reaches, however, suggests that she has improperly accepted the IPCC and CCSP reports without conducting her own analysis and exercising her own judgment.

B. EPA Ignores Evidence that Current Temperatures and Climate Are Not Consistent with Model Predictions.

1. EPA misses studies showing that the Agency overstates the amount and rate of the warming since mid-1970s, the period when EPA says temperature rise is of such magnitude that it is "highly likely" to be caused by anthropogenic GHGs.

EPA's conclusion that current warming can be attributed to anthropogenic GHG emissions is substantially based on the conclusion that the warming trend that began at the end of the Little Ice Age in the late 1880s has accelerated in recent decades. EPA notes that recent years are the warmest in the 100-year record, and states that the rate of warming over the last 50 years is 0.13°C/decade, a rate that it says is double the rate of warming of the last 100 years. TSD at 23.

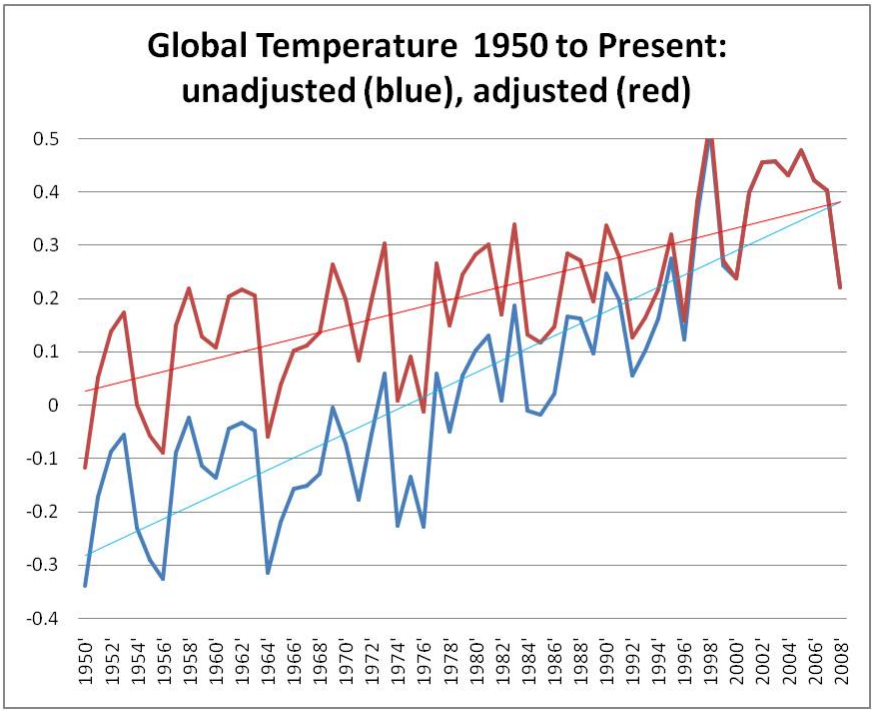
EPA misses several important points, however. In the first place, as shown in the Agency's own Figure 4.2 (TSD at 23), the rate of warming from the 1970s forward is essentially the same rate as between 1910 and 1940, a period when EPA does not believe warming was significantly caused by GHG emissions. The fact that the last fifty years warmed at twice the rate as the entire 100-year period is reflective of the flat temperatures at the beginning of the record prior to 1910, and does not indicate that the rate of warming since 1970s is unprecedented in the 100-year record.

Moreover, EPA fails to discuss a number of scientific papers showing that the rate of warming in the second half of the 100-year record may be overstated and also may be explained by other causes:

a. No cooling in mid 20th C?

As much as half of the 0.13°C/decade rise found by EPA in the last fifty years appears to be a result of mistakes in data analysis, as demonstrated by Thompson *et al*. (2008), a reference from *Nature* that EPA does not discuss. The Thompson paper shows that the presumed drop in

global surface temperature in the 1940s is apparently an artifact of adjustment of measurements of sea-surface temperature. Compensating for this makes the beginning of the last 50-year period warmer than previously thought, thus lowering the rate of warming over that period. As a result, a portion of the net warming thought to be a result of changes in GHGs is in fact a result of error in early measurement techniques. A simple linear adjustment for the findings of Thompson *et al*. reduces the 1950-2008 warming trend from 0.11°C/decade to 0.06°C, as shown in Figure 1 below. Since EPA relies on the rate of warming in the last 50 years to support its conclusion that such warming is "highly likely" to have been caused by anthropogenic GHGs, EPA must explain the effect on its conclusion of a study showing that the rate of warming, in fact, may be half of what EPA presumed. *See* discussion at Michaels at 1-2.



Hadley surface temperatures after adjustment for Thompson *et al*. (2008).
From Steven McIntyre, *ClimateAudit*.

b. Data issues.

EPA further fails to adequately discuss a substantial body of literature indicating that biases in the land-based temperature records may mean that the warming is over-represented in these datasets. EPA briefly refers to the well-known urban heat island effect, where urban warming trends may be influenced by development around the area where the thermometers are located. EPA dismisses the urban heat island effect based on the IPCC's view that such effect is localized and does not affect overall global trends. TSD at 22. EPA, however, ignores a great deal of literature suggesting otherwise. Given that EPA depends on the amount and rate of warming of the last 50 years to conclude that such warming is "highly likely" to be the result of anthropogenic GHG emissions, EPA must supply its own reasoned analysis of these data issues. Idso, § 2.5 presents a full discussion of the literature that EPA did not examine on the urban heat island issue. EPA must respond.

Apart from the urban heat island issue, recent literature suggests other reasons to think that temperature data sets may be overestimating the extent to which the warming of the last 50 years may be the result of anthropogenic GHG emissions:

- For instance, McKitrick and Michaels (2007) found a nonurban ("socioeconomic," in their parlance) bias of +0.04°C per decade (beginning in 1979) as a result of land-use, geography and variables pertaining to data quality. Proportionally adjusting this for the lower trend in the last half-century that *must* result from Thompson *et al*., lowers warming by an additional 0.02°/decade since 1979, resulting in a reduced *overall* warming trend of only 0.05°C/decade.

- Similarly, EPA did not discuss Klotzbach *et al*. (2009), which further documented biases in land-based temperature records including "poor exposure of observing sites, effects on temperature trends of concurrent multi-decadal trends in the local surface air humidity; microclimate, non-spatially representative land use change over time, movement of temperature measurements closer to buildings, changes in the turbulent state of the nocturnal boundary layer by surface development and aerosols, and the sampling of temperature data at single heights." Klotzbach *et al*. postulated that net effect of these biases has induced a substantial artificial

warming in the land-based surface temperature record. This would, again, reduce the overall amount and rate of actual warming over the last fifty years.

- Additionally, EPA did not reference Pielke, Sr., *et al*., (2007) who found persistent warm biases in the U.S. Historical Climate Network instrumentation. This Network is one of the most important components of global climate histories.

See Michaels at 2-4.

c. Solar influence.

EPA also ignored Scafetta and West (2006, 2007), which found that roughly 25 percent of the warming since 1979 was a result of solar variation. As this is independent of the findings of McKitrick and Michaels (2007) and Pielke, Sr., *et al*. (2007), addition of these citations would further lower greenhouse warming below the 0.05°C/decade noted above. *See also* de Laat and Maurellis (2006); Michaels at 4.

d. Black carbon.

Although EPA referred to a recent study by Ramanathan and Carmichael (2008), EF at n. 24, which examined new science on the climate impacts of black carbon aerosol, EPA failed to discuss the significance of the study for its conclusion that the warming of the last 50 years is highly likely the result of anthropogenic GHG emission. EF at 18898 states that "a recent study referenced in the TSD estimated that black carbon is having a much stronger direct warming effect … compared to the IPCC's estimate." (Footnote omitted.) The TSD states, "A more recent estimate suggests a direct black carbon effect of 0.9 (0.4 to 1.2) W/m^2, or more than half that of CO_2 (Ramanathan and Carmichael, 2008)."

As discussed in Michaels at 3, this estimate of the effect of black carbon on warming has a very significant effect on the extent to which the warming of the last 50 years can be attributed to the six GHGs that are the subject of EPA's Endangerment Finding Proposal. EPA states that

"the combined radiative forcing due to the cumulative increase in atmospheric concentrations of carbon dioxide, methane, and nitrous oxide [three of the six GHGs that are the subject of the Endangerment Finding Proposal] over the period 1750 to 2005 is 2.3 W/m^2," reflecting the IPCC numbers. EF at 18896. The IPCC lists the radiative forcing from the build-up of the other three GHGs (halocarbons) as 0.34W/m2, bringing the total radiative forcing increase from the six greenhouse gases covered by the Endangerment Finding Proposal to 2.64W/m2.

Ramanathan and Carmichael's conclusion that forcing for black carbon is 0.9W/m2 means that black carbon contributes about 25% of the total positive forcing (0.9/(2.64+0.9)). The IPCC AR4 best-estimate of the radiative forcing effect from black carbon is given a 0.20±0.15W/m2 (IPCC AR4, p. 165) – or only 7% (0.2/(2.64+0.2)) of the total positive forcing. Thus the new estimate of the radiative forcing from black carbon means that the total radiative forcing increase is now considered to be 25% greater than reported by the IPCC (3.54W/m2 compared to 2.84W/m2), which means that the warming since mid-century that has been caused by the six greenhouse gases covered by the *Proposed Endangerment* is ~25% less than the IPCC estimates (as black carbon explains the rest).

e. Sum.

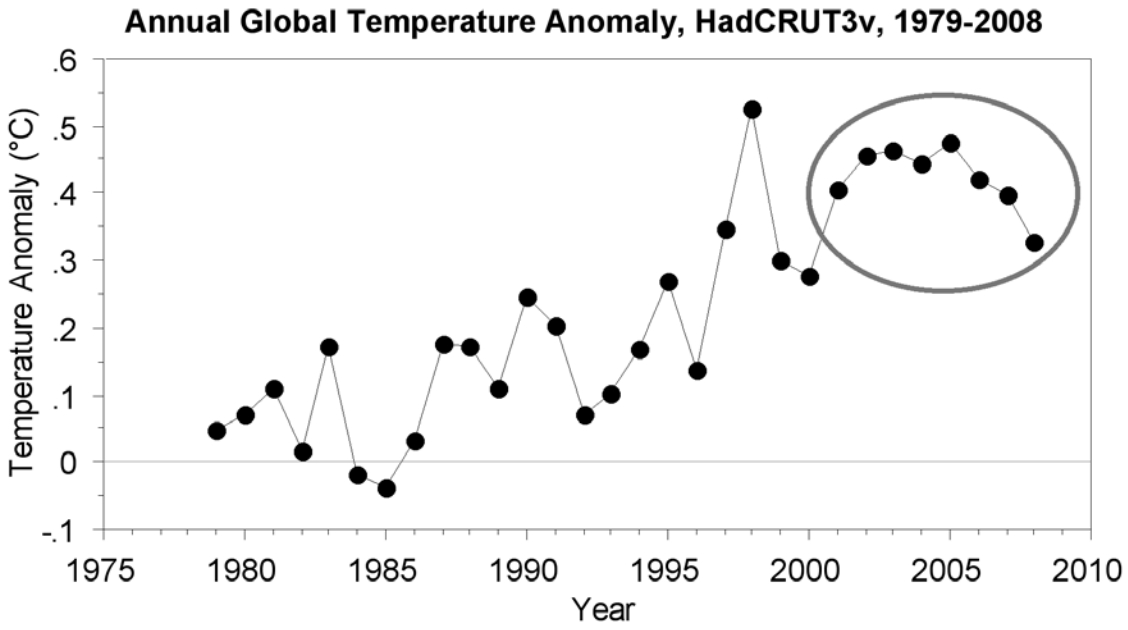
In sum, this combination of data demonstrates that a key finding of the Endangerment Finding Proposal – that the buildup of GHGs is very likely to be the cause of most of the observed warming in the last 50 years – may very well be wrong. Together, the measurement error in the actual temperature change noted by Thompson *et al*. (2008), the artificial warming bias in the land-based surface temperature observations as noted by McKitrick and Michaels (2007), Klotzbach *et al*. (2009), Pielke *et al*. (2007), and de Laat and Maurellis (2006), and the new estimate of the warming impact of black carbon reported by Ramanathan and Carmichael

(2008), indicate that *less* than half of the warming estimated by EPA could be a result of GHG changes. *More, perhaps considerably more*, than half of the warming may be the result of trend errors since 1950, other measurement issues, and a better understanding of the radiative impact of black carbon. These issues are too significant for EPA to ignore.

2. EPA fails to discuss the cooling trend since 1998.

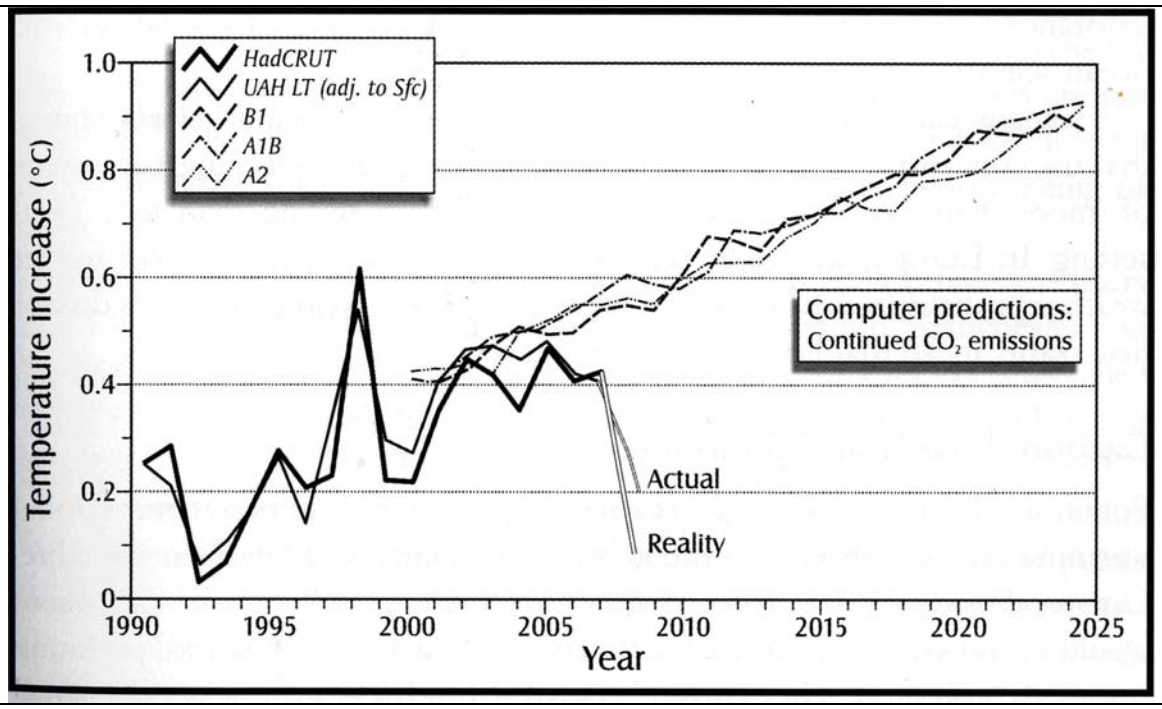
EPA places great reliance on its statement that eight of the last ten years have been the warmest in the record, TSD at ES-2, but that statement lacks context. As EPA notes, the planet has been steadily warming since the end of the Little Ice Age in the 19th Century. As this warming trend is undisputed in general (although the amount of warming is in dispute), it is not remarkable that temperatures at the current time are warmer than at any time on record, since the "record" EPA refers to began at the end of the Little Ice Age.

As important, however, EPA ignores the fact that the trend since 1998 is cooling and that this cooling trend was not predicted by any of the GCMs. Instead, the GCMs all predict a steady rate of warming reflective of steadily increasing GHG emissions. As discussed in Michaels at 4, the following figure shows temperature trends since 1978. Although the last decade remains warm as compared to previous periods, temperatures have unexpectedly dropped in recent years.



Global temperature anomalies, 1979-2008. While the years 2001-2008 are indeed warm with respect to the rest of the record, there is clearly no trend in temperature during that period or for several years prior to then.

This downward trend in recent temperature is completely inconsistent with GCM forecasts. Ian Plimer (2009) demonstrated the significance of this fact by examining the forecasts produced by the 2000 IPCC models. These are the same models that the IPCC ran for the IPCC Fourth assessment Report, and it can be seen that these models failed to provide an accurate prediction ***within their first decade of prediction, let alone fifty or one hundred years***.



Ian Plimer (2009) comparison of IPCC projections made in 2000 with actual Hadley and UAH MSU LT adjusted to surface

EPA, however, does not provide any discussion of the significance of the reduction of temperatures over the last ten years or of the failure of the models to predict it.

3. EPA fails to account for the models' over-prediction of increasing temperatures.

The course of global temperatures thus far in the 21st century *is statistically different* (less than) the projections made by the suite of climate models employed by the IPCC to make climate projections. Michaels *et al*. (2009) compared the observed global surface temperature trends to the collective temperature trends projected by the 22 models included in the IPCC Fourth Assessment Report. The trend in the average global temperature is the most fundamental large-scale climate measure – one that is imperative for the models to emulate correctly if they are to accurately model the global climate system. Michaels *et al*. (2009), appended to the attached Michaels report, ran a series of statistical tests aimed at assessing the climate model performance

during the longest period possible of overlap between observations and climate model projections – which begins in January 2001. Michaels *et al*. (2009) examined the climate model projections made from the IPCC SRES A1B emissions scenario which represents a "middle-of-the-road" emissions projection – as noted in the Endangerment Finding Proposal, the projections from climate models, regardless of the emission scenario, are similar for the first several decades of the 21st Century, so the Michaels *et al*. (2009) tests are representative of the model behavior of the entire suite of emission scenarios as they pertain to the climate evolution during the first several decades of this century.

Michaels *et al*. (2009) sought to answer two fundamental questions:

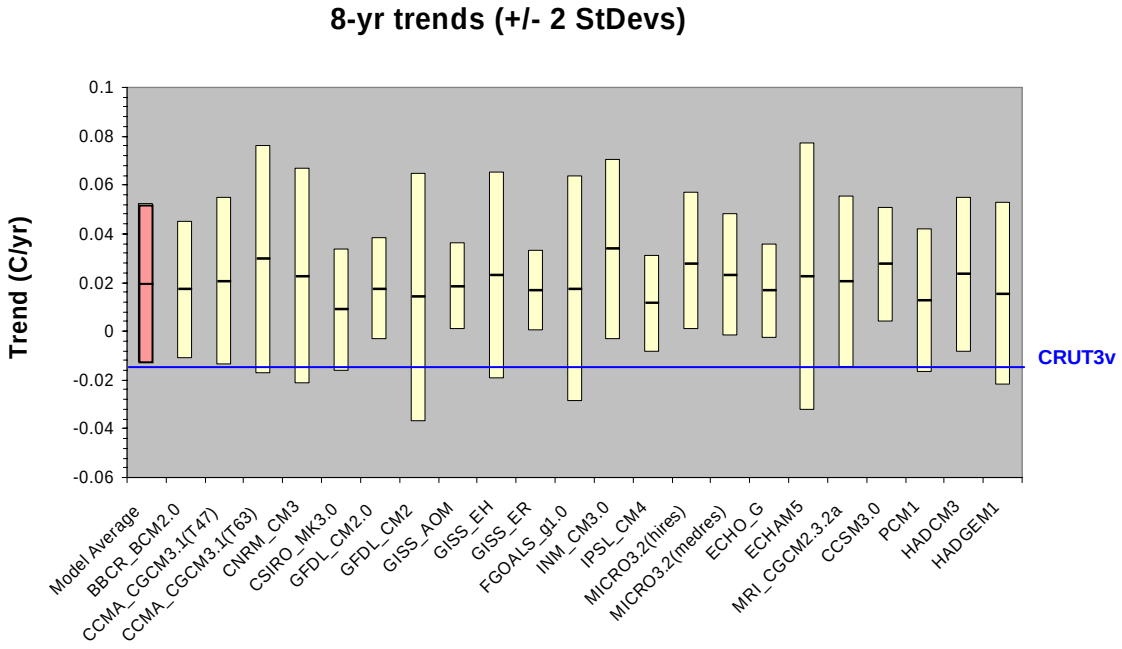
1) Is the observed temperature trend equal to the mean model projected temperature trend?

2) Where does the observed temperature trend fall within the distribution of model projections of the trend?

The answer to question 1 was an unequivocal "no." Taken together, collective climate model projections were unable to accurately capture the observed trend in global temperatures. The observed trend during the period January 2001 through April 2009 fell well outside of the 95% confidence bounds of the model mean trend. Statistically speaking, this signifies that there was a significant difference between the model mean temperature trend and the observed temperature trend – a strong indication that the models and the observations were not representing the same system, in this case, the earth's climate. Since the observations represent reality, the models therefore, do not.

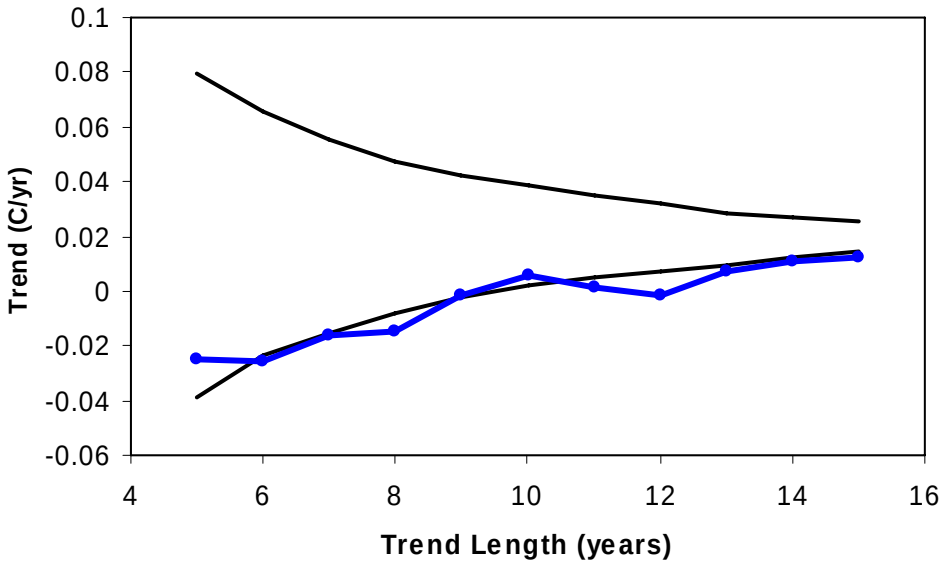
In answering question 2, Michaels *et al*. (2009) examined the projected 8-yr trends through all available individual A1B runs during the first two decades of the 21st Century from

each of the 22 climate models incorporated in the IPCC Fourth Assessment Report. Michaels *et al*. (2009) developed the 95% confidence range of the distribution of projected 8-yr temperature trends from each climate model. Figure 12 shows that the observed temperature trend through the first 8 years of the 21st Century (2001 through 2008) lies below the model average projected trend (red box) and also below the 95% confidence range of 12 of the 22 individual models. The observed trend falls very near the low end of the 95% confidence range of the remaining 10 climate models. This result indicates that at least 12 of the 22 available climate models have failed, while the other 10 models are close to failing, in their ability to accurately project the actual large-scale behavior of the earth's climate system. If the models are unable to foretell the large-scale climate behavior, so too are they unable to accurately project regional scale climate behavior.



The 95% confidence range of model projected 8-yr trends during the first two decades of the 21st century. The red box represents the model average, while the yellow boxes represent the projections from individual models. The observed global average temperature trend (from the data compiled by the U.K.'s Climate Research Unit) are indicated by the horizontal blue line. (from Michaels *et al*. 2009)

As an additional test, Michaels (2009, Congressional Testimony) compared the observed trends to climate model projections for trends ranging in length from 5 to 15 years. The Figure below summarizes the comparison of the 95% confidence range of the model trends with the observed trend for each trend length from 5 to 15 years (ending in December 2008). Again, the model collective failure is evident. The observed trends of length 7, 8, 11, 12, and 13 years all fall below the lower bound of the 95% confidence range of all model trends of that length – meaning that the observed trend is statistically significantly different than the collection of model trends for those trend lengths – while the observed trends at the remaining lengths (5, 6, 9, 10, 14, and 15 years) lie very near the lower 95% confidence bound. Again, these results point to failed or failing climate models.



The 95% confidence range of collection of trends through the global average temperatures of lengths ranging from 5 to 15 years as projected by 22 climate models during the first two decades of the 21st century when run under the IPCC SRES A1B (middle-of-the-road) emissions scenario (black lines). The trend through the observed global average temperature observations (as compiled by the U.K.'s Climate Research Unit) are also shown (blue line) (from Michaels 2009).

4. EPA fails to account for the lack of warming and the increase in sea ice in the Antarctic.

EPA admits that there is no evidence of warming in Antarctica and that Antarctic sea ice is expanding rather than contracting. TSD at 32. The Agency, however, fails to provide a detailed analysis of the numerous scientific studies on the subject. Moreover, the Agency fails to explain how the lack of warming and expansion of sea ice at the South Pole is consistent with its conclusion that the current warming is caused by anthropogenic GHG emissions and with GCM predictions that the opposite should be occurring. EPA's failure to discuss Antarctic climate is discussed further in Idso, § 3.2.1.

a. Antarctic Temperatures.

Temperature observations from Antarctica have not shown an increase over the past few decades. The observational data, in fact, reveal that the modern rise in atmospheric CO_2 has had no discernible influence on Antarctic temperatures. The TSD, however, fails to fully acknowledge this fact, claiming instead that there is "insufficient observational coverage to make an assessment." TSD at 42. In fact, studies of Antarctic near-surface and tropospheric air temperatures reveal that the region as a whole experienced a significant cooling trend, and corresponding increases in sea ice area and extent, from 1966-2000. Comiso (2000); Watkins and Simmonds (2000); Doran *et al.* (2002).

In spite of the decades-long cooling that has been observed for the continent as a whole, the Antarctic Peninsula/Bellingshausen Sea region has warmed over the same time period. With respect to whether or not the temperature increase is evidence of CO_2-induced global warming, Vaughan *et al*. (2001) note that sediment cores from 6000 to 1900 years ago suggest the Prince Gustav Channel Ice Shelf – which collapsed in this region in 1995 – "was absent and climate was as warm as it has been recently" when there was much less CO_2 in the air. As a result, to

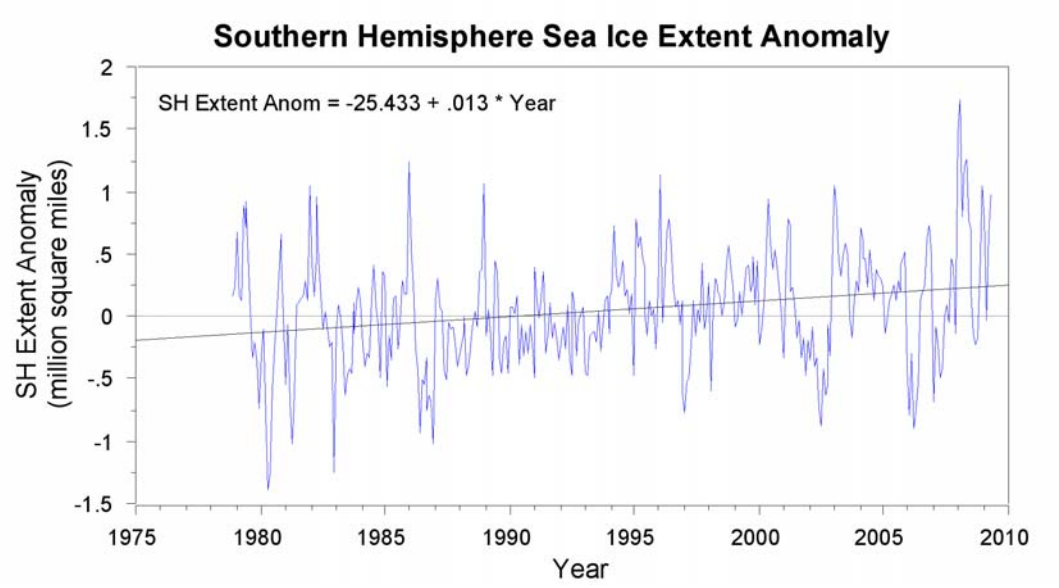
cite the 20th century increase in atmospheric CO_2 concentrations as the cause of the recent regional warming, and "to do so without offering a mechanism," say Vaughan *et al*., "is superficial." Thompson and Solomon (2002) furthermore suggest that much of the warming in this particular region can be explained by "a systematic bias toward the high-index polarity of the SAM [Southern Hemispheric Annular Mode]." *See also* Kwok and Comiso (2002).

b. Antarctic Sea Ice.

Current observational trends in Antarctic sea ice do not comport with the supposition that anthropogenic warming will result in increased sea ice melt in Antarctica. Important, peer-reviewed scientific studies have concluded, "continually increasing sea ice extent over the Antarctic Southern Polar Ocean, along with the observed decreasing trends in Antarctic ice surface temperature (Comiso, 2000) over the last two decades, is paradoxical in the global warming scenario resulting from increasing greenhouse gases in the atmosphere." Vyas *et al.* (2003). Vyas *et al.* (2003) reached their conclusions by studying satellite data for the period 1978-2001 showing that not only did the mean rate of change of sea ice extent for the entire Antarctic region reveal an increase, but also, "the increasing trend in the sea ice extent over the Antarctic region may be slowly accelerating in time, particularly over the last decade."

In fact, the ice in Antarctica set a new record for extent in 2007 and, despite EPA's concern as to the western Antarctica peninsula, the total Antarctic ice extent continues to run about 1 million square km above the 1979-1998 average, as shown in the figure below. Indeed, as discussed in Michaels at 45, there is a statistically significant upward trend in the monthly sea-ice extent data for the southern hemisphere (see figure below). Data from the National Snow and Ice Data Center (http://nsidc.org./data/seaice_index), from November 1978 through April 2009 has a statistically significant ($p<.0001$) upward trend of 12,000 square kilometers per year. The

Southern Hemisphere ice extent anomaly is so great that as of this writing (May, 2009), *global* sea-ice is approximately a million square kilometers *above* the 1979-2000 mean.



Monthly Southern Hemisphere sea ice anomalies and best-fit linear trend line (data source: NSIDC. ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/).

Finally, a study by Liu *et al.* (2004) conducted extensive statistical analysis of satellite data for sea ice extent and area and found that trends showing increases in total Antarctic sea ice area and extent exceed a 95% confidence interval and are robust for three different total ice concentrations. Studies by Watkins and Simmonds (2000), Yuan and Martinson (2000), Hanna (2001), Zwally *et al*. (2002), Parkinson (2002 and 2004), Cavelieri *et al.* (2003), Comiso and Nishio (2008), and Cavalieri and Parkinson (2008) support findings of statistically significant increases in Antarctic sea ice extent, area, and season. The Antarctic region both as a whole and as broken down into five longitudinal sectors exhibits increasing concentration trends and spring-summer albedo trends. Laine (2008). Cavelieri and Parkinson (2008), furthermore, found that from 1998 to 2006 both the extent and area of Antarctic sea ice increased and the extent of sea ice increased at a more rapid rate than it did from 1979 to 1998.

5. EPA fails to adequately discuss evidence that the vertical atmosphere is not responding to increasing GHG concentrations as predicted by the GCMs.

A signal that the present warming is the result of anthropogenic GHG emissions would be in the behavior of the vertical atmosphere. Climate models all predict that anthropogenic global warming will bear a unique fingerprint in the form of an increasing warming trend with altitude in the tropical troposphere, the region of the atmosphere up to about 15 kilometers (See Figure below). Climate changes due to solar variability or other known natural factors will not yield this pattern; only sustained greenhouse warming will do so. Warming of the vertical atmosphere consistent with model predictions would be considered to be a "fingerprint" of warming caused by anthropogenic GHG emissions.

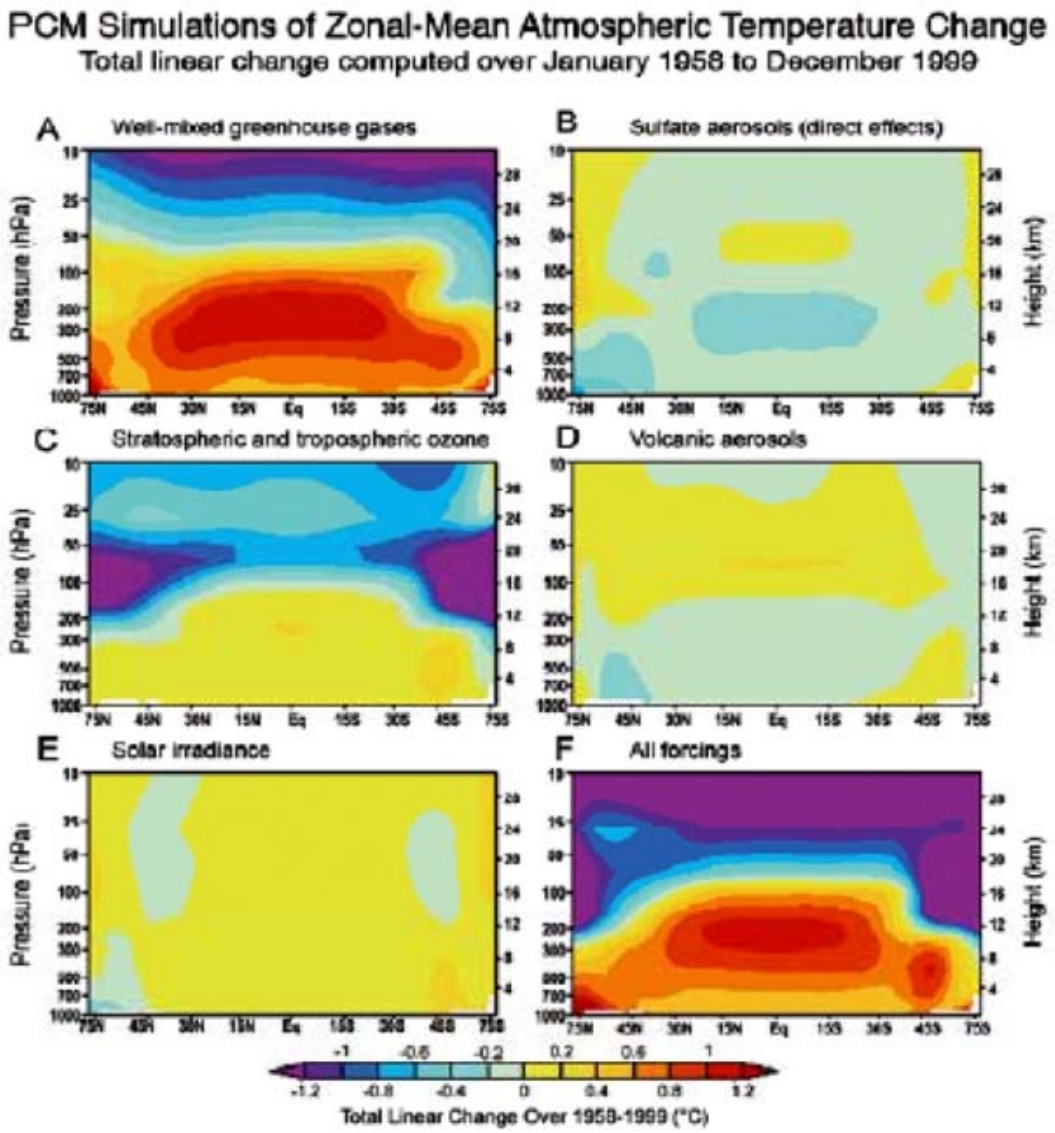
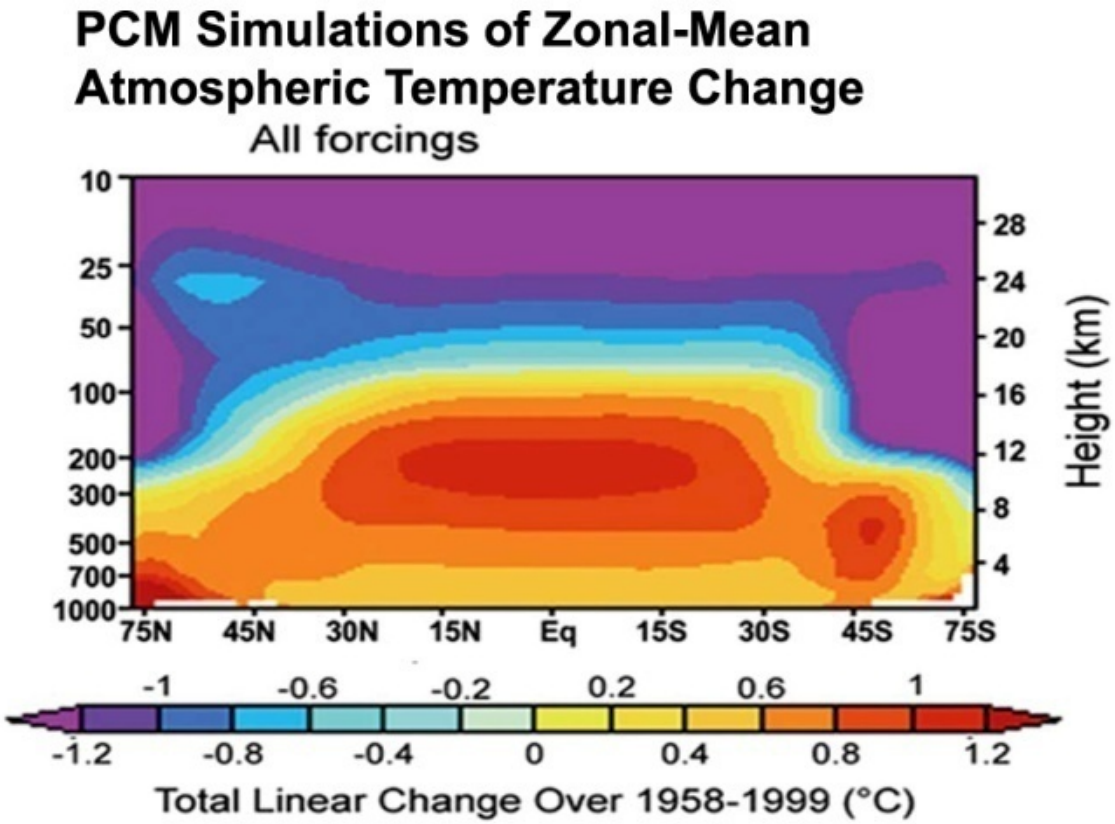


Figure 1.3. PCM simulations of the vertical profile of temperature change due to various forcings, and the effect due to all forcings taken together (after Santer *et al.*, 2000).

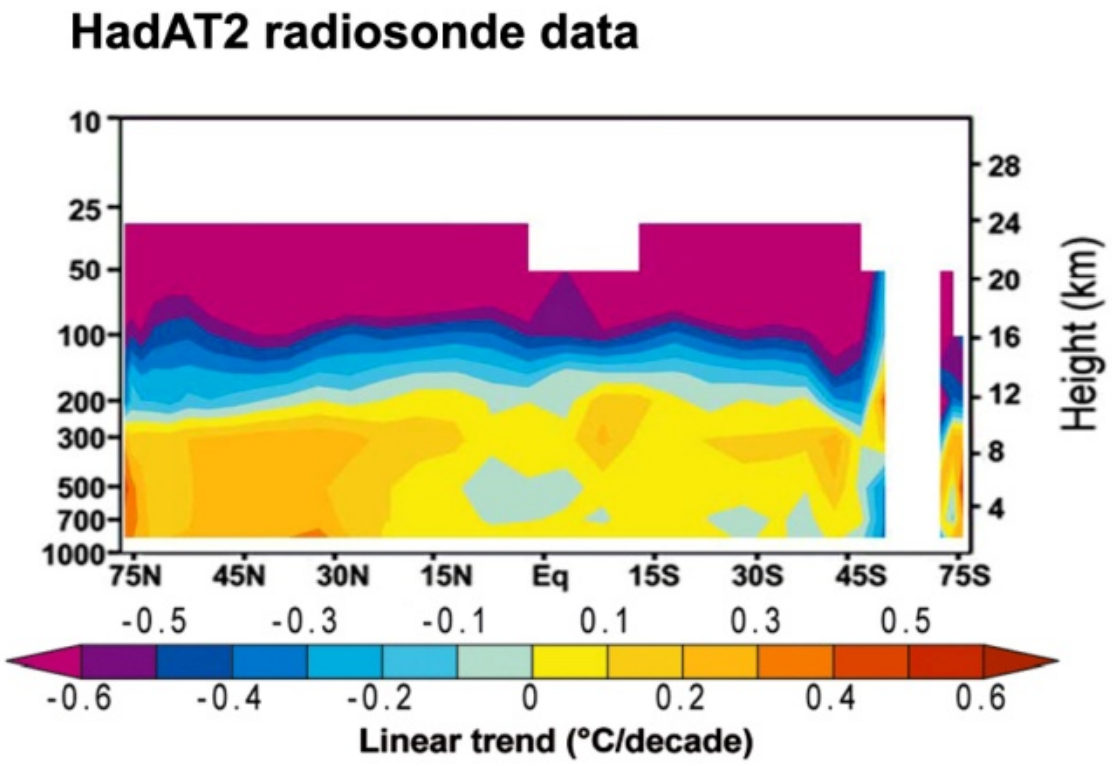
Model-calculated zonal mean atmospheric temperature change from 1890 to 1999 (degrees C per century) as simulated by climate models from [A] well-mixed greenhouse gases, [B] sulfate aerosols (direct effects only), [C] stratospheric and tropospheric ozone, [D] volcanic aerosols, [E] solar irradiance, and [F] all forcings (U.S. Climate Change Science Program 2006, p. 22). Note the pronounced increase in warming trend with altitude in figures A and F, which the IPCC identified as the 'fingerprint' of greenhouse forcing.

With the availability of higher-quality temperature data, especially from balloons and satellites, and with improved models, it has become possible to test whether such a fingerprint exists in the vertical atmosphere. This was done in a report issued by the CCSP in April 2006 – making it readily available to the IPCC for its Fourth Assessment Report – and it permits the most realistic comparison of fingerprints (Karl *et al*., 2006).

CCSP 2006 is an outgrowth of a National Academy of Sciences (NAS) report "Reconciling Observations of Global Temperature Change" issued in January 2000 (NAS, 2000). That NAS report compared surface and troposphere temperature trends and concluded they cannot be reconciled. Six years later, the CCSP report expanded considerably on the NAS study. It is essentially a specialized report addressing the most crucial issue in the global warming debate: Is current global warming anthropogenic or natural? The CCSP result is unequivocal. While all greenhouse models show an increasing warming trend with altitude, peaking around 10 km at roughly two times the surface value, the temperature data from balloons give the opposite result: no increasing warming, but rather a slight cooling with altitude in the tropical zone. See the two figures below, taken directly from the CCSP 2006.



Greenhouse-model-predicted temperature trends versus latitude and altitude; this is figure 1.3F from CCSP 2006, p. 25. Note the increased temperature trends in the tropical mid-troposphere, in agreement also with the IPCC result (IPCC-AR4 2007, p. 675).



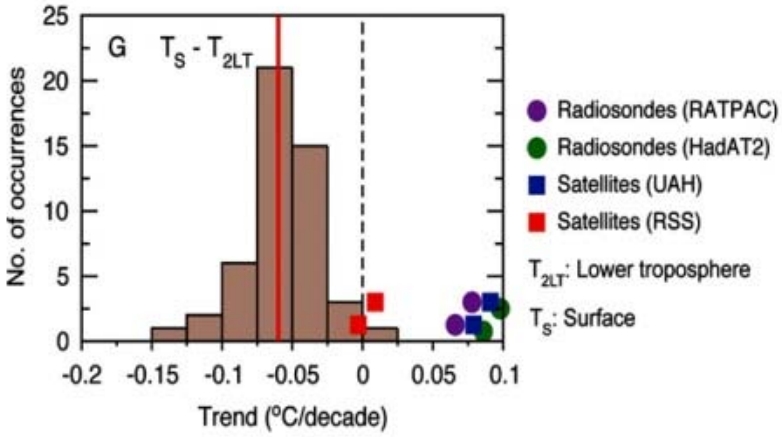
By contrast, observed temperature trends versus latitude and altitude; this is figure 5.7E from CCSP 2006, p. 116. These trends are based on the analysis of radiosonde data by the Hadley Centre and are in good agreement with the corresponding U.S. analyses. Notice the absence of increased temperature trends in the tropical mid-troposphere.

The CCSP executive summary inexplicably claimed agreement between observed and calculated patterns, the opposite of what the report itself documents. It tried to dismiss the obvious disagreement shown in the body of the report by suggesting there might be something wrong with both balloon and satellite data.

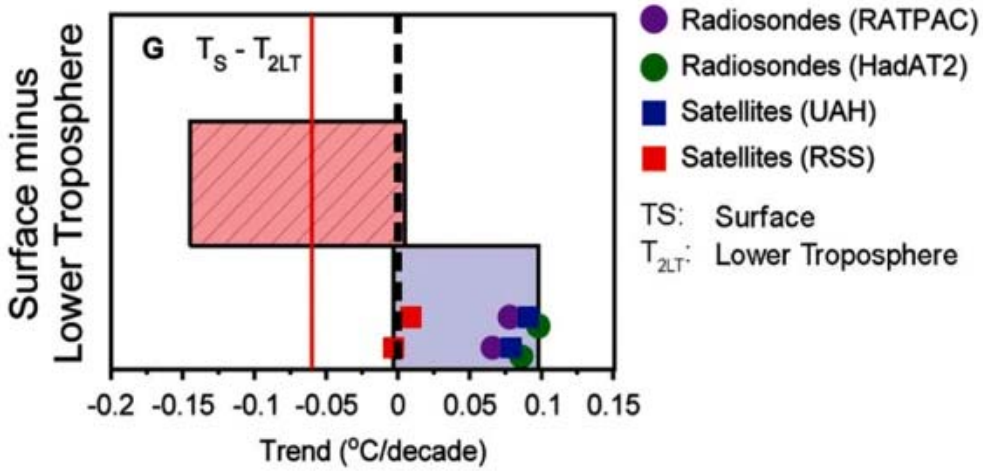
The same information also can be expressed by plotting the difference between surface and tropospheric trends for both the models and for the data (Singer, 2001). As seen in the figure below, the models show a histogram of negative values (i.e. surface trend less than troposphere trend) indicating that atmospheric warming will be greater than surface warming. By contrast, the data show mainly positive values for the difference in trends, demonstrating that measured warming is occurring principally on the surface and not in the atmosphere.

Modeled and Observed Temperature Trends in the Tropics (20°S - 20°N)

a.



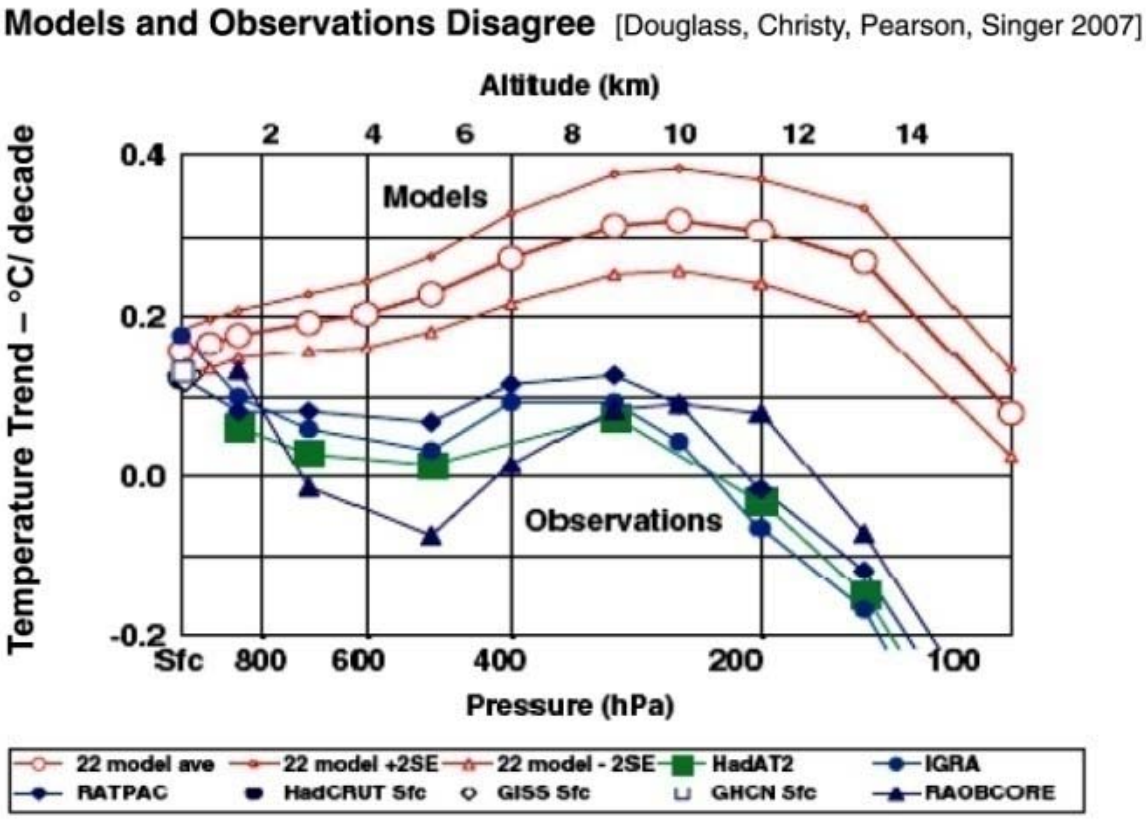
b.



(a) Another way of presenting the difference between temperature trends of surface and lower troposphere; this is figure 5.4G from CCSP 2006, p. 111. The model results show a spread of values (histogram); the data points show balloon and satellite trend values. Note the model results hardly overlap with the actual observed trends. (The apparent deviation of the RSS analysis of the satellite data is as yet unexplained.)

(b) By contrast, the executive summary of the CCSP report presents the same information as Figure 3.4.4 in terms of 'range' and shows a slight overlap between modeled and observed temperature trends (Figure 4G, p. 13). However, the use of 'range' is clearly inappropriate (Douglass et al. 2007) since it gives undue weight to 'outliers.'

The disparity between model predictions and actual data was noted by Douglass *et al*. (2004, 2007), as shown in the figure below, a study not referenced by EPA. Douglass *et al*. expressed his results as follows, demonstrating that the models show an increase in temperature trend with altitude but the observations show the opposite.



A more detailed view of the disparity of temperature trends is given in this plot of trends (in degrees C/decade) versus altitude in the tropics [Douglass et al. 2007]. Models show an increase in the warming trend with altitude, but balloon and satellite observations do not.

This mismatch of observed and calculated fingerprints would appear to clearly falsify the hypothesis of anthropogenic global warming, and at a minimum calls into question whether the GCMs can be relied on as accurately simulating current and future climate. The TSD, nevertheless, almost completely fails to discuss this evidence. EPA cites Karl *et al* (2006) as

evidence of an anthropogenic fingerprint on present warming, but notes that "an apparent inconsistency may have been identified in the tropics." EPA correctly notes that, "[i]n the tropics, most observational data sets show more warming at the surface than in the troposphere, while almost all model simulations have larger warming aloft than at the surface." EPA concludes, however, that "[a] possible explanation for this inconsistency is error in the observations, but the issue is still under investigation." TSD at 41.

This explanation is wholly insufficient. Of course, inaccuracies in the data would explain the failure of model predictions to comport with the data, but EPA does not suggest any basis to believe that the data is wrong. At this point, a more plausible explanation is that the models are incorrectly simulating current climate and that a necessary fingerprint of anthropogenic warming is missing. At the very least, EPA should have provided a detailed discussion of the significance of Douglass (2007) and the fact that GCM simulations of the vertical atmosphere are contradicted by actual data.

6. EPA ignores evidence that the oceans are not accumulating heat as predicted by the models.

The GCMs project that the oceans should be monotonically accumulating heat as radiative forcing increases with the accumulation in the atmosphere of GHGs. For instance, Hansen (2005) stated that "[c]onfirmation of the planetary energy imbalance can be obtained by measuring the heat content of the ocean, which must be the principal reservoir for excess heat. They concluded that a decade (1993-2003) of increasing ocean heat confirmed the accuracy of GISS model projections.

EPA's discussion of the GCMs, however, fails to discuss the fact that, more recently, ocean heat accumulation has stopped and even reversed, as demonstrated by data from the ARGO buoy array and from satellite measurements of ocean heights. Willis calculates a net loss

of -0.12 (±0.35) x 10^{22}Joules per year (Pielke, *Physics Today,* 55) from mid-2003 to the end of 2008. Loehle 2009 calculates the loss at -0.35 (±0.2) x 10^{22}Joules per year from mid-2003 to the end of 2007 (see Loehle, 2009: "Cooling of the global ocean since 2003." *Energy & Environment*, **Vol. 20**, No. 1&2, 101-104(4)). In his blog, "Update On A Comparison Of Upper Ocean Heat Content Changes With The GISS Model Predictions" (climatesci.org, Feb. 9, 2009), Pielke takes a conservative approach and assumes zero heat accumulation for the full six-year period (2003-2008), yielding a deficit of 5.88 x 10^{22}Joules.

The demonstrated failure of the oceans to accumulate heat in recent years would seem to demonstrate the inability of the models to accurately simulate climate and would seem to suggest that a mechanism other than anthropogenic GHGs was responsible for the accumulation of heat in the oceans prior to mid-2003. EPA must discuss why the models remain a valid tool for climate analysis given this evident deficiency.

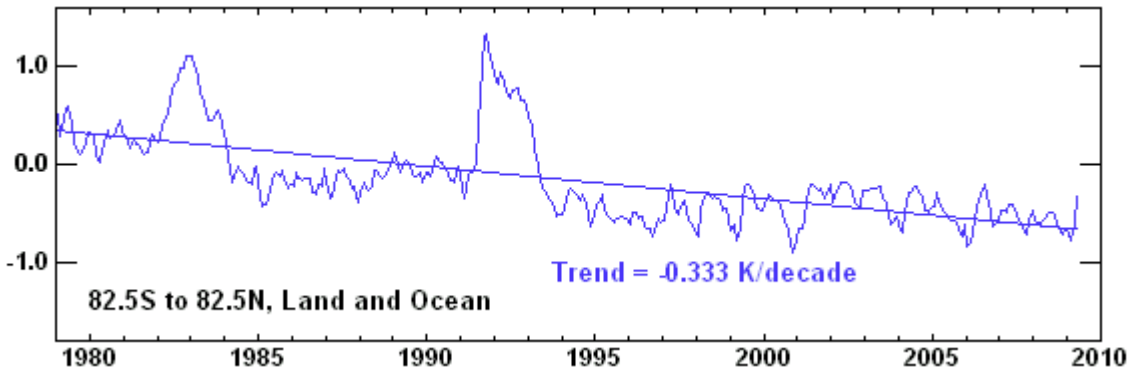
7. EPA ignores the fact that lower stratospheric cooling has slowed.

The GCMs predict the accumulation of GHGs in the atmosphere will result in a cooling of the atmosphere. EPA states that data confirms the GCM predictions in this regard:

> Estimates from adjusted radiosondes, satellites and re-analyses are in qualitative agreement, suggesting a lower-stratospheric cooling of between 0.3°C and 0.6°C per decade since 1979.

TSD at 25.

As Michaels at 41 explains, apart from the fact that the term "qualitative agreement" lacks scientific meaning, EPA fails to mention that the rate of stratospheric cooling has slowed greatly during the past decade and a half. In fact, there has been virtually no temperature trend in the satellite datasets of stratospheric temperatures since the mid-1990s (see figure below, or see IPCC AR4, Figure 3.17).



Lower stratospheric temperature history as measures by MSU satellites (data source, Remote Sensing Systems, http://www.ssmi.com/msu/msu_data_description.html#msu_amsu_time_series)

8. EPA fails to discuss the fact that CO_2 methane concentrations are stabilizing.

Increases in atmospheric methane concentrations have slowed, contrary to model expectations. EF at 18895/2 notes that methane concentration "has increased by 149% since preindustrial levels" (through 2007). Methane is the second most-important anthropogenerated GHG. EPA failed to note that methane concentration increases began to slow in the 1980s and have actually declined in some recent years (Dlugokencky *et al*. (1998); Schiermeier (2006). Every projection made by the IPCC (though less-so for the highly improbable B1) assumes methane increases at at least the pre-1980 rate at least through 2040.

Note that a new paper by Rigby *et al*. (2008) reports on an uptick in global methane emissions in 2007, but the cause, and whether or not it represents the re-establishment of an upward trend, or simply interannual variability, has not been established. Their observations of a simultaneous increase of similar magnitudes in both hemispheres remain unexplained, as there should be disproportionate increases in the Northern Hemisphere. Preliminary data from 2008 indicate that the year-over-year rise from 2007 to 2008 was less than half of that of 2006 to 2007, and close to the slow growth rate which has characterized the past decade. *See* http://www.noaanews.noaa.gov/stories2009/20090421_carbon.html.

9. EPA fails to discuss science showing errors in model assumptions as to the mechanics of the atmosphere and atmospheric sensitivity to rising GHGs.

Given that the Endangerment Finding Proposal is so heavily dependent on the GCMs, EPA surprisingly overlooks a significant body of scientific literature questioning whether the models correctly simulate the physics of the atmosphere. This literature is reviewed in Idso, Ch. 1. As shown in that literature review, science has revealed numerous deficiencies in the GCMs, some of which could even alter the sign of projected climate change as a result of rising GHGs. These deficiencies relate to model treatment of radiation, clouds, precipitation, soil moisture and others.

In particular, EPA's projection of a 3°C equilibrium warming in response to doubled CO2 is not primarily the result of a direct atmospheric response to the heat-trapping characteristics of GHGs but is critically dependent on GHGs creating a warming feedback, particularly increased cloudiness. But, as shown in the Idso literature review, EPA ignores a large body of research showing that feedback effects may have the opposite effect of that assumed by the GCMs, with the potential to cancel the direct radiative effect of increased GHGs.

In this regard, a number of recent articles by leading climate researcher Roy W. Spencer of the University of Alabama demonstrate that GCMs may fundamentally misrepresent the role of clouds and therefore produce far too much warming in response to anthropogenic GHG emissions. We understand that Spencer will be filing comments in this proceeding, further explaining his work and citing his research. EPA must respond.

C. EPA Ignores Evidence that the Present State of the Climate Is Hardly Unprecedented and Therefore Cannot Be Attributed to Anthropogenic GHG Emissions.

EPA fails to discuss many scientific studies showing that the Earth has been much warmer during prior periods of the current interglacial period (the Holocene) and that the

extreme weather conditions that EPA cites as evidence of an anthropogenic influence have occurred in much more extreme form before, including within the last one hundred years. EPA does not adequately explain how climate conditions that occurred prior to the time when GHG concentrations were influenced by man can be cited as evidence that anthropogenic GHG emissions are causing the climate to change.

1. EPA fails to discuss the fact that global temperatures and atmospheric CO_2 concentrations have not been associated over geologic time.

The question of whether current climate conditions are so exceptional as to evidence a human cause is best addressed in context of the current interglacial period, roughly the last 12,000 years, since this period reflects the present global climate system. Nevertheless, it is worth briefly reviewing studies of climate across geological time – none of which are discussed by EPA – to demonstrate that there is no necessary association between atmospheric CO_2 and global temperature. This contrasts with EPA's assertion that GHGs "have a positive forcing because they absorb and reradiate in all directions outgoing, infrared radiation that would otherwise directly escape into space." TSD at 19. That statement is true, but EPA fails to give it context in light of the considerable scientific evidence that increasing CO_2 in the atmosphere does not necessarily cause increasing temperatures. This issue is discussed in more depth in Idso, § 2.1.

For example, the TSD does not attempt to reconcile its conclusions with Rothman's derived 500-million-year history of atmospheric CO_2 concentrations. Based on physical data, Rothman (2002) found that for the majority of the last half of a billion years atmospheric CO_2 concentrations have fluctuated between two and four times present value and that at this scale *there is no correlation between increased CO_2 and increased temperature*. Indeed, the three most significant peaks in CO_2 correspond with relatively cool climatic conditions.

Nor does the TSD reconcile or even discuss Pagani *et al.* (2005), which argued that there is a decoupling between global climate and CO_2. Looking at the last 50 million years, they found numerous periods where CO_2 and temperature appear to be completely independent. For example, CO_2 levels experienced three huge oscillations over a ten million year period (between 43 and 34 million years ago), yet for the bulk of this period temperatures were gradually declining. Then, during the third peak in CO_2 concentrations, the temperature *declined* sharply. Other periods showed consistent global temperatures during times of wildly divergent CO_2 concentrations (e.g., increases by 500 ppm and decreases by 1000 ppm). Still other periods had falling CO_2 concentrations during periods of increased temperatures.

Some studies, also not addressed by the TSD, have found a correlation between CO_2 and temperature; however, these studies, using numerous and varied methods, indicate that CO_2 *lags* global temperature – suggesting that if there is an association, it is opposite of the one EPA assumes. (Genthon *et al.*, 1987; Fischer *et al.*, 1999; Petit *et al*., 1999; Indermuhle *et al*., 2000; Monnin *et al*., 2001; Mudelsee, 2001; Caillon *et al*., 2003). To take just one of these studies as an example, Petit *et al*. (1999) looked at the beginnings of glacial ages and found that CO_2 decreases lag temperature decreases by several thousand years. They also found that the interglacial period we are now in is 2ºC cooler than the five most recent interglacial periods, yet the CO_2 concentrations now (~390 ppm) are higher than they were in any of these other periods, having never exceeded approximately 290 ppm during the predecessor interglacial periods.

In the face of these studies and this evidence, it may be that there is a direct correlation between CO_2 and global temperature as EPA assumes. But EPA must at least address the geologic temperature record that seems to suggest otherwise.

2. EPA ignores evidence that temperatures have been as warm and warmer for a number of periods during the Holocene, including within the last one thousand years.

EPA states that, "[p]aleoclimatic information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1300 years." TSD at 27. This statement ignores significant information showing that it is both misleading and wrong. Evidence not discussed by EPA shows that global temperatures were significantly warmer than present (at lower atmospheric GHG concentrations) during a number of points in the current interglacial period – during the Holocene Climate Optimum between six and eight thousand years ago and about five thousand years ago, again about three thousand years ago, and then again during the Roman Climate Optimum about two thousand years ago. Thus, even if EPA is correct about the last 1300 years, the statement lacks context and would not be evidence that current temperatures are caused by anthropogenic GHG emissions. See Idso, § 3.2.2.1.

Additionally, numerous studies indicate that EPA is wrong about the last 1300 years. These studies indicate that during the Medieval Warming Period, about A.D. 900 to 1000, temperatures were as warm as or warmer than they are at present.

Idso, § 2.4 summarizes a large synthesis of Medieval Warming Period research articles. This material shows that the overwhelming majority of the studies indicate that the Medieval Warming Period was, in fact, warmer than the current period. EPA, however, bases its conclusions with respect to current "unprecedented" temperatures primarily on only three studies, all with the same primary author – Mann *et al*. (1998), Mann *et al*. (1999) and Mann and Jones (2003). In contrast, Idso, § 2.4 summarizes individually more than fifty peer-reviewed studies, using diverse methodology and in various geographic settings, that indicate the contrary point – that the Medieval Warming Period *is* precedent for current temperatures.

The mere existence of these current, peer-reviewed, scientific studies – let alone the logical collective implication of them – demands EPA's consideration. EPA cannot lawfully rely on three studies, while it ignores numerous others conflicting studies.

3. EPA ignores the fact that the current warming in the Arctic is not unprecedented.

EPA places great reliance on current warming conditions in the Arctic, both because the Arctic appears to be in a warming period and because, as noted, the GCMs predict disproportionate warming in the Arctic. Again, however, EPA's discussion of Arctic warming and sea ice melting fails to address many studies showing that current conditions are not unprecedented and that, indeed, there was greater warming and less sea ice in the Arctic at other times during the current interglacial period, including relatively recently, than at present. EPA's failure to discuss studies of Arctic and Greenland climate conditions is discussed further in Idso, § 3.5.

a. Temperatures.

The TSD ignored several studies focusing on Greenland and the rest of the Arctic region which do not support a causal link between atmospheric GHG concentrations and Arctic temperatures.

Greenland

Dahl-Jensen *et al.* (1998) studied data from ice sheet boreholes to reconstruct the temperature history of Greenland over the past 50,000 years. Their analysis showed periods of colder and warmer temperatures than at present, maximum temperatures around 1930, and temperatures that decreased during the last decades. Keigwin and Boyle (2000), McDermott *et al.* (2001), Wagner and Melles (2001), and Seppa and Birks (2002) likewise found evidence of worldwide, regional, and Greenland-specific temperature fluctuations consistent with a Medieval

Warm Period (roughly 800 to 1200 AD) and Little Ice Age (roughly 1350 to 1860 AD). The peak warmth of the Medieval Warm Period with its mild climate and associated high surface productivity in the fjord, in fact, likely was a major factor in enabling Scandinavians to establish long-enduring settlements on the coast of Greenland around 990 AD. Lassen *et al.* (2004). Those settlements declined and eventually failed during the harsh cold of the Little Ice Age, with the last recorded presence of the Norse in South Greenland noted in 1408 AD. Jensen *et al.* (2004). The post-Little Ice Age era (from around 1850 to the present) has been associated with "naturally initiated" warming. Kaplan *et al.* (2002).

In another study of Greenland climate that included both glacial and interglacial periods, Bard (2002) reviews the concept of rapid climate change, noting glacial-period millennial-scale episodes of dramatic warming (more than 10°C) called Dansgaard-Oeschger events, which are evident in ice-core records, and episodes of drastic cooling (up to 5°C) called Heinrich events, which are evident in sea surface temperature records derived from deep-sea sediment cores. All dramatic warming and cooling events detected to date occurred in either full glacial periods or transitional periods between glacials and interglacials, suggesting that unless the earth begins drifting towards glacial conditions, it is unlikely there will be any dramatic warming or cooling surprises in the near future.

Concentrating on the 20th century, Hanna and Cappelen (2003) analyzed the air temperature history of the Greenland region from 1958-2001. They noted important regional exceptions to recent warming and found that "recent cooling may have significantly added to the mass balance of at least the southern half of the [Greenland] Ice Sheet." Przybylak (2000) found that "the level of temperature in Greenland in the last 10-20 years is similar to that observed in the 19th century." Likewise, Comiso *et al.* (2001) analyzed the Greenland Sea winter ice cover

and determined that it was relatively smaller several decades ago due to warmer temperatures prevalent at that time. Taurisano *et al*. (2004) found that temperature data for the Nuuk fjord showed warming during the first 50 years of the 1900s, followed by cooling and an increase in the number of snowfall days over the second half of the century. Finally, Chylek *et al.* (2004) studied temperature records from three coastal stations in southern and central Greenland and found that Greenland's peak temperatures occurred between 1930 and 1940 and "summer temperatures, which are the most relevant to Greenland ice sheet melting rates, do not show any persistent increase during the last fifty years." They concluded that Greenland as a whole has not experienced any net warming over the most dramatic period of atmospheric CO2 increase on record and, in fact, has cooled during this period.

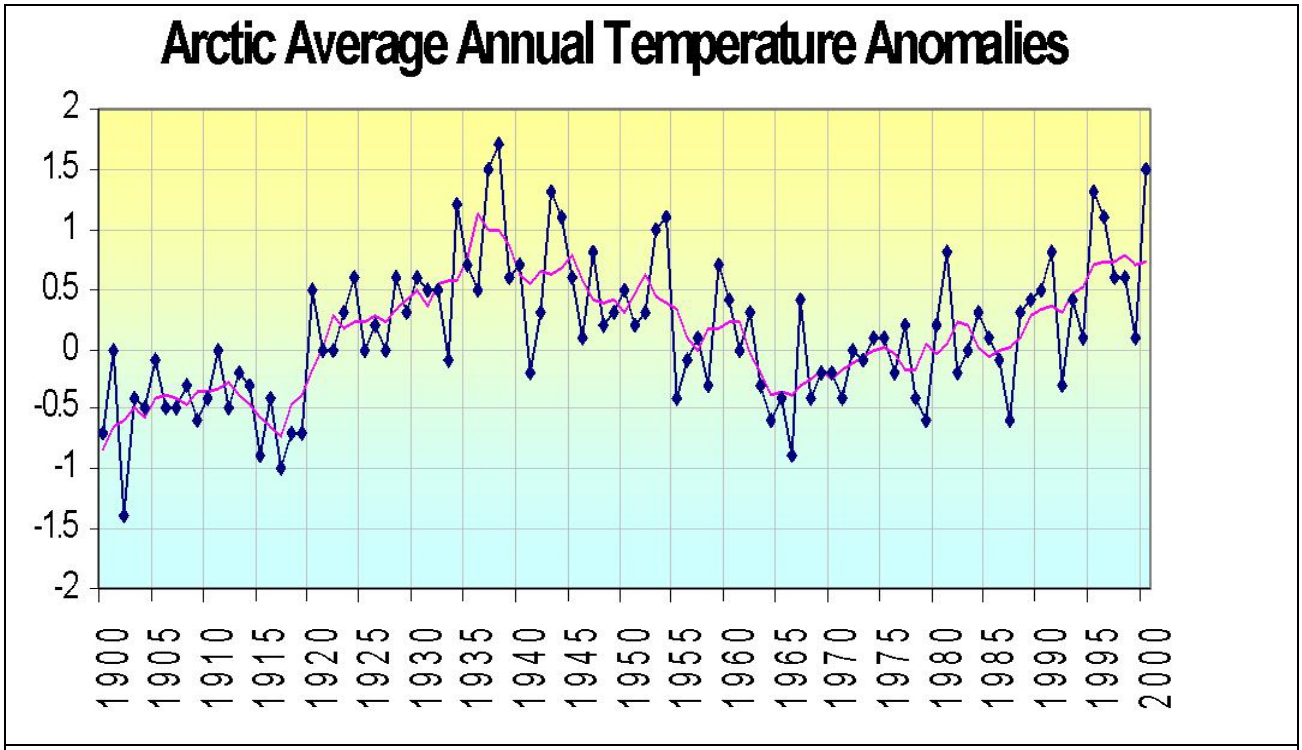
Rather than showing unusual or unprecedented warming trends, these many studies of the temperature history of Greenland on the contrary depict a long-term oscillatory cooling ever since the mid-Holocene period, when it was about 2.5°C warmer than now. The peak Greenland temperature was experienced in the 1930s, only to fall steadily thereafter. The TSD ignores these highly relevant temperature studies.

Rest of the Arctic

As is the case with the Greenland region, numerous respected scientists have studied other areas within the Arctic region and found temperature trends that are the result of natural oscillations rather than unusual or unprecedented warming due to anthropogenic forces. Several studies have found that throughout the Arctic region, temperature fluctuations (such as the Medieval Warm Period, Little Ice Age, a warming period from around 1850 through the first half of the 20th century, and a cooling period during the second half of the 20th century) are common occurrences, thus making temperature trends highly dependent upon the particular time period

selected for analysis. Kasper and Allard (2001), Zeeberg and Forman (2001), Gedalof and Smith (2001), Naurzbaev *et al*. (2002), Polyakov *et al.* (2002b), Humlum *et al.* (2005), Hanna *et al*. (2006). In this context, there is nothing unusual about trends observed in recent decades. Hansen *et al*. (2006), in fact, found that there have been changes in Arctic temperatures during the last decade, but that "similar changes in air temperatures [had] occurred previous[ly] within the last 130 years," and the changes over the last decade "are on the same order as changes [that] occurred between 1920 and 1930."

Polyakov *et al* (2002) is instructive in this regard. This paper created a temperature record using stations north of 62 degrees N. The late 1930s-early 1940s were clearly the warmest of the last century. In addition, the numbers of available observations in the late 1930s-early 1940s (slightly more than 50) is comparable to recent decades. The annual temperatures are plotted in the Figure below.



Arctic Basin wide temperatures (Polyakov 2003)

Additional studies have found that when trends are analyzed over several time periods, the data actually suggests that recent years are exhibiting a cooling or neutral trend, not the warming trend adopted by the TSD. Bradwell *et al.* (2006), for example, examined the link between fluctuations in climate and glacial ice caps and found that there is a close correspondence between summer air temperature and the rate of ice-front recession. They additionally found that ice front recession was greatest during the 1930s and 40s, then slowed in the 1960s, and "there has been little overall retreat since the 1980s." Groisman *et al*. (2006) similarly studied records of snow cover and ground freezing and concluded that "changes in snow cover extent during the 1936-2004 period cannot be linked with 'warming' (particularly Arctic warming)," because, "in this particular period the Arctic warming was absent." Studying the ages of dissolved organic carbon in Arctic rivers, Benner *et al.* (2004) found strong evidence that there has been no large-scale recent warming in the Arctic region. Vaganov *et al.* (2000) analyzed air temperature trends and found a cooling trend since 1940. *See also* Laidre and Heide-Jorgensen (2005); Humlum *et al*. (2005). And Comiso *et al*. (2001) found that based upon observations of the Odden ice tongue, there has been little to no warming in most parts of the Arctic for the past seven decades. *See also* Isaksson *et al.* (2003), Polyakov *et al*. (2003), Briffa *et al*. (2004), Drinkwater (2006).

Other scientists have looked to non-anthropogenic factors as much more likely factors behind such temperature trends than the anthropogenic explanation offered by the TSD. Vaganov *et al*. (2000) found that where warming existed in the record, between around 1820 and 1940, much of it correlated with changes in solar irradiance (*see also* Soon (2005)) and volcanic activity, two factors that are free of anthropogenic influence. Moore *et al.* (2001). Raspopov *et al*. (2004) found that alternating regimes of relatively warmer and cooler air and sea surface

temperatures were common occurrences, with a warming period from around 1850 to 1950 associated with the region's natural thermal recovery from the Little Ice Age.

The ultimate conclusion from many of these studies is that there is no observable relationship between recent CO_2 levels and temperatures in the Arctic region, contrary to the conclusions of the TSD. Polyakov *et al.* (2004), for example, found that Arctic surface air temperatures and Atlantic core water temperatures are dominated "by multidecadal fluctuations with a time scale of 50-80 years" and that late 20th Century warmth was not the result of CO_2-induced global warming because the air's CO_2 concentration in the late 1930s and 40s was 65 ppm less than it is today, yet the warmth of that period was essentially equivalent to that of today. Overpeck *et al.* (1997) developed a 400-year history of circum-Arctic surface air temperature. They determined that the most dramatic warming of the last four centuries occurred between 1840 and 1955, over which period the air's CO_2 concentration rose by 28 ppm; from 1955 to the end of the record (around 1990), the air temperature declined while the CO_2 concentration rose by 41 ppm. Overall, they found that the rate of rise of surface air temperature did not correspond to atmospheric CO_2 concentrations and, in fact, over the last 35 years studied, it declined while atmospheric CO_2 concentrations rose greatly. Przybylak (1997, 2000) likewise concluded, based upon analysis of air temperature variability, that "in the Arctic in the period 1951-90, no tangible manifestations of the greenhouse effect can be identified." *See also* Karlen (2005).

All of these observations are at odds with the findings of the TSD, including its reliance upon Mann *et al.* (1998, 1999), but are not analyzed therein.

b. Sea Ice Extent.

The TSD states that Arctic sea ice extent has shrunk since 1978 and is projected to continue shrinking. Arctic climate is complex, however, varying simultaneously on a number of different timescales for a number of different reasons. Venegas and Mysak, 2000. Against this backdrop, as multiple studies ignored by the TSD indicate, it is extremely difficult to identify an anthropogenic signal in sea ice extent trends.

Studies have found that multiyear ice dynamics data generally is insufficient to project long-term trends in sea ice coverage, partly because of natural short-term oscillations in coverage. Belchansky *et al*. (2004). In other words, studies examining Arctic sea ice trends demonstrate how difficult it is to reach conclusions about long-term decreases or increases in coverage. Heige-Jorgensen and Laidre (2004); Cavalieri *et a*l. (2003). As Grumet *et al.* (2001) have described the situation, recent trends in Arctic sea ice cover "can be viewed out of context because their brevity does not account for interdecadal variability, nor are the records sufficiently long to clearly establish a climate trend." Johannessen *et al.* (1999), for example, found that although Arctic sea ice extent declined over the period 1978-1998, the decrease in sea ice extent did not occur smoothly over the 20 year study period but rather occurred abruptly over a one to three year period around 1989 and indicated that sea ice extent may in fact have actually increased from 1990/1991 onward. Kwok (2004) likewise found that Arctic sea ice extent increased over the period 1999-2003, and Parkinson (2000b) found that much of the Arctic experienced increasing sea ice extent from 1990 to 1999.

In an effort to overcome this "short-sightedness," Grumet *et al*. developed a 1000-year record of spring sea ice conditions in the Arctic region of Baffin Bay based on sea-salt records from an ice core. They determined that after a period of reduced sea ice in the 11th-14th centuries, enhanced sea ice conditions prevailed for the following 600 years. For the final

century of this period, however, "despite warmer temperatures during the turn of the century, sea-ice conditions in the Baffin Bay/Labrador Sea region, at least during the last 50 years, are within 'Little Ice Age' variability," suggesting that sea ice extent has not yet emerged from the range of conditions characteristic of the Little Ice Age.

Several other peer-reviewed studies by respected scientists note a great variety of both temperature and Arctic sea ice extent trends over various periods, suggesting high climate variability and several historic periods of climatic transition. Comiso *et al*. (2001); Omstedt and Chen (2001); Jevrejeva (2001); Vinje (2001). Other studies note increased accumulation and other changes in the largest ice cap in the Eurasian Arctic that could have wide-ranging implications for Arctic sea ice extent. Bamber *et al.* (2004). The TSD makes no mention of these studies.

With such oscillations, it is difficult if not impossible to conclude, as the TSD did, that there has been a consistent trend of Arctic warming, much less attribute any observable warming to anthropogenic sources. Polyakov *et al.* (2002) found that "smaller than expected" trends in sea ice cover "do not support the hypothesized polar amplification of global warming." They went on to find that trends of lower sea ice coverage are not statistically significant. Polyakov *et al.* (2003). Divine and Dick (2006) used historical April through August ice observations made in the Nordic Seas for the period 1750-2002 to conclude that oscillations of ice cover indicated that "persistent ice retreat since the second half of the 19th century" began well before anthropogenic CO_2 emissions could have had a significant effect on the earth's climate. They suggest, furthermore, that "during decades to come ... the retreat of ice cover may change to an expansion."

Such findings do not support the TSD position that Northern Hemisphere sea ice is rapidly disintegrating in response to CO_2-induced global warming. Rather, the oscillatory behavior observed in so many sea ice studies suggests, "the possibility of close connections between the sea ice cover and major oscillatory patterns in the atmosphere and oceans." Parkinson (2000b).

c. Sea Ice Thickness.

The TSD relied heavily upon studies cited by the IPCC, Rothrock *et al*. (1999) and Wadhams and Davis (2000), that suggest Arctic sea ice has thinned by nearly 50% over the prior few decades, and attribute the thinning to anthropogenic global warming. The TSD, however, ignored several studies that suggest otherwise or at least demonstrate that no clear trends concerning sea ice thickness can be determined.

In a comprehensive study, Windsor (2001), for example, analyzed sea ice data and concluded that "mean ice thickness has remained on a near-constant level around the North Pole from 1986 to 1997." Holloway and Sou (2002) likewise analyzed a number of different data-fed model runs and found that for the last half of the past century, "no linear trend [in Arctic sea ice volume] over 50 years is appropriate," noting that their results indicate "increasing volume to the mid-1960s, decadal variability without significant trend from the mid-1960s to the mid-1980s, then a loss of volume from the mid-1980s to the mid-1990s." The net effect was that "the volume estimate in 2000 is close to the volume estimated in 1950." Polakov *et al*. (2002 and 2003) also concluded there are no statistically significant trends in fast-ice thickness.

Johannessen *et al.* (1999) found that a decline in sea ice thickness did not occur smoothly over a 20 year study period, but rather occurred abruptly over a one to three year period around 1989. Dumas *et al*. (2003) similarly noted that "a sharp decrease in ice thickness of roughly .6m

over 4 years (1970-74) [was] followed by an abrupt increase of roughly .8m over 2 years (1974-76)." Laxon *et al*. (2003) also observed that "sea ice mass can change by up to 16% within one year," and "until models properly reproduce the observed high-frequency, and thermodynamically driven, variability in sea ice thickness, simulations of both recent, and future, changes in Arctic ice cover will be open to question."

Other studies furthermore have shown that variations in sea ice thickness may be explained by non-anthropogenic factors such as periodic movement of shallow Arctic shelves (Pfirman *et al*. (2004)) and asymmetry resulting from the variability of air temperature, snow depth, and the dates of ice freeze-up and break-up. Gagnon and Gough (2006). None of these phenomena associated with natural consequences of changes in ice dynamics, however, were discussed in the TSD.

4. EPA fails to account for the fact that extreme weather events have frequently occurred in the past and at greater intensity than now being experienced.

EPA believes that extreme weather events demonstrate that anthropogenic GHG emissions are significantly contributing to climate change. EPA refers to extremes in temperatures, precipitation and storms, droughts and high sea levels. EPA's citation of studies, however ignores numerous studies showing that extreme weather events are neither increasing nor unprecedented. Indeed, as summarized by researcher Roger Pielke Jr., who has published extensively on this subject, the conclusions of CCSP 2008i as to extreme weather events can be summarized as follows:

> And the U.S. Climate Change Science Program recently issued a report ["Weather and Climate Extremes in a Changing Climate"] with the following conclusions:
>
> 1. Over the long-term U.S. hurricane landfalls have been declining.
>
> 2. Nationwide there have been no long-term increases in drought.

> 3. Despite increases in some measures of precipitation, there have not been corresponding increases in peak streamflows (high flows above 90th percentile).
>
> 4. There have been no observed changes in the occurrence of tornadoes or thunderstorms.
>
> 5. There have been no long-term increases in strong East Coast winter storms (ECWS), called Nor'easters.
>
> 6. There are no long-term trends in either heat waves or cold spells, though there are trends within shorter time periods in the overall record.[4]

A review of the studies that EPA unaccountably failed to discuss demonstrates these points in more detail. Idso, Ch. 4 discusses these studies in more depth for all the types of extreme climate events on which EPA relies for its conclusion that an anthropogenic warming is underway. We discuss below four of the most significant types of extreme weather: drought, storminess, tropical cyclones and floods.

a. Drought.

EPA inexplicably cites increased droughts as a sign of increased extreme weather that is consistent with anthropogenic warming, but its evidence consists of the following statement from the IPCC as to droughts in the United States: "Droughts are becoming more severe in *some* regions, though there are no clear trends for North America as a whole." TSD at 37 (emphasis supplied). In the same vein, EPA cites evidence that "most of the United States experienced reductions in drought severity and duration over the 20th Century. However, there is some indication of increased drought severity and duration in the western and southwestern United States." TSD at 37. EPA does not explain, however, why no trend towards increased droughts in North America – or a trend towards reduction in droughts – is evidence of increasing extreme

[4] Pielke Jr.'s citations to the CCSP report are contained here: http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/index.html#001462.

droughts nor whether the fact that droughts are becoming extreme in some areas is out of the historical norm.

In fact, Idso's review of literature not cited by EPA shows that there is nothing unusual about drought in all of North America during the 20th Century. Idso, § 4.1.4. Large historic droughts have occurred naturally here in the past during times when there was much less CO_2 in the air than there is currently. They would thus be expected to occur again naturally, independent of atmospheric GHG concentrations.

For the Western United States, the area that appears to be of concern to EPA, among the many studies that EPA ignored, as summarized by Idso, § 4.1.4.3, are:

- Gray *et al*. (2004a). Working in the Bighorn Basin of north-central Wyoming and south-central Montana, these researcher used cores and cross sections from 79 Douglas fir and limber pine trees at four different sites to develop a proxy for annual precipitation spanning the period AD 1260-1998. This reconstruction, in their words, "exhibits considerable nonstationarity, and the instrumental era (post-1900) in particular fails to capture the full range of precipitation variability experienced in the past ~750 years." More specifically, they say that "both single-year and decadal-scale dry events were more severe before 1900," and that "dry spells in the late thirteenth and sixteenth centuries surpass both [the] magnitude and duration of any droughts in the Bighorn Basin after 1900." In fact, they say that "single- and multi-year droughts regularly surpassed the severity and magnitude of the 'worst-case scenarios' presented by the 1930s and 1950s droughts."

- Benson *et al*. (2002), which developed continuous high-resolution $\delta^{18}O$ records from cored sediments of Pyramid Lake, Nevada, which they used to help construct a 7600-year history of droughts throughout the surrounding region. Oscillations in the hydrologic balance that were evident in this record occurred, on average, about every 150 years, but with significant variability. Over the most recent 2740 years, for example, intervals between droughts ranged from 80 to 230 years; while drought durations ranged from 20 to 100 years, with some of the larger ones forcing mass migrations of indigenous peoples from lands that could no longer support them. In contrast, historical droughts typically have lasted less than a decade.

- Mensing *et al*. (2004). This study also examined sediment cores extracted from Pyramid Lake, Nevada, and analyzed pollen and algal microfossils deposited there over the prior 7630 years that allowed them to infer the hydrologic history of the area over that time period. Their results indicated that "sometime after

3430 but before 2750 cal yr B.P., climate became cool and wet," but, paradoxically, that 'the past 2500 yr have been marked by recurring persistent droughts." The longest of these droughts, according to them, "occurred between 2500 and 2000 cal yr B.P.," while others occurred "between 1500 and 1250, 800 and 725, and 600 and 450 cal yr B.P," with none recorded in more recent warmer times.

- Gray *et al*. (2004b), which used samples from 107 piñon pines at four different sites to develop a proxy record of annual precipitation spanning the AD 1226-2001 interval for the Uinta Basin watershed of northeastern Utah. This effort revealed, in their words, that "single-year dry events before the instrumental period tended to be more severe than those after 1900," and that decadal-scale dry events were longer and more severe prior to 1900 as well. In particular, they found that "dry events in the late 13th, 16th, and 18th Centuries surpass the magnitude and duration of droughts seen in the Uinta Basin after 1900."

Similarly, in the southern and southwestern United States (which are part of the subtropics), paleo-evidence shows that droughts occurred in the past 1,000 years that have dwarfed any modern droughts both in terms of intensity and duration (see http://www.ncdc.noaa.gov/paleo/drought/drght_home.html for example, or Seager et al., 2008).

Idso also examined numerous studies for other regions of the United States, as well as the United States as a whole, all showing similar results. It is worth highlighting the studies for the central United States, summarized in Idso, § 4.1.4.2, because this is the region of the 1930s Dust Bowl, the worst U.S. drought of the 20th Century. Obviously, if the Dust Bowl happened before, it could happen again independently of atmospheric GHG levels. These studies show that the Dust Bowl drought was far from unprecedented in the historical record:

- Fritz *et al*. (2000) utilized data derived from sediment cores retrieved from three North Dakota lakes to reconstruct a 2000-year history of drought in this portion of the Northern Great Plains. This work suggested, in their words, "that droughts equal or greater in magnitude to those of the Dust Bowl period were a common occurrence during the last 2000 years."

- Shapley *et al*. (2005). Working in the Northern Great Plains, but extending down into South Dakota, this study developed a 1000-year hydroclimate reconstruction from local bur oak tree-ring records and various lake sediment cores. Based on this record, they determined that prior to 1800, "droughts tended towards greater persistence than during the past two centuries," revealing that droughts of the

region became shorter-lived as opposed to longer-lasting as the earth gradually recovered from the cold temperatures of the Little Ice Age.

- Laird *et al*. (1998). Working with a high-resolution sediment core obtained from Moon Lake, North Dakota, which provided a sub-decadal record of salinity (drought) over the past 2300 years, this study discovered that the U.S. Northern Great Plains were relatively wet during the final 750 years of this period. In fact, throughout the 1550 prior years, the study determined that "recurring severe droughts were more the norm," and that they were "of much greater intensity and duration than any in the 20th century," including the great Dust Bowl event of the 1930s.

- Forman *et al*. (2005), which identified six major aeolian depositional events in the past 1500 years, all but one of which (the 1930s "Dust Bowl" drought) occurred prior to the 20th century. Moving backwards in time from the Dust Bowl, the next three major events occurred during the depths of the Little Ice Age, the next one near the Little Ice Age's inception, and the earliest one near the end of the Dark Ages Cold Period. As for how the earlier droughts compare with those of the past century, the researchers say the 1930s drought (the 20th century's worst depositional event) was less severe than the others, especially the one that has come to be known as the 16th-century megadrought. Forman *et al*. thus conclude that the aeolian landforms they studied "are clear indicators of climate variability beyond twentieth century norms, and signify droughts of greater severity and persistence than thus far instrumentally recorded."

Idso, § 4.1.4.1 summarizes many similar studies for Canada as well, including Gan (1998) analyzing the duration, magnitude and severity of drought in Alberta, Saskatchewan and Manitoba; St. George and Nielsen (2002), who reconstructed annual precipitation in southern Manitoba since AD 1409; Campbell (2002), who produced a high-resolution record of climate variability at Pine Lake, Alberta over the past 4000 years; Carcaillet *et al*. (2001), who reconstructed fire frequency in the Climatic Optimum of the mid-Holocene, between about 7000 and 3000 years ago; Girardin *et al*. (2004), who developed a 380-year reconstruction of the Candaian Drought Code, a numerical rating of the average moisture content of deep organic layers in boreal conifer stands that is used to monitor fire danger; Wolfe *et al*. (2005), who conducted a multi-proxy hydro-ecological analysis of Spruce lake in the northern Peace sector of the Peace-Athabasca Delta in northern Alberta; and Zhang and Hedba (2005), who conducted

dendroclimatological analyses of 121 well-preserved subfossil logs discovered at the bottom of Heal Lake near the City of Victoria on Vancouver Island plus 29 Douglas-fir trees growing nearby that led to the development of an ~ 4,000-year chronology exhibiting sensitivity to spring precipitation. Based on these studies, it would appear that most of Canada has experienced significantly *less* drought as it and the rest of the world have emerged from the cold conditions of the Little Ice Age and entered the current period of relatively higher temperatures.

Idso, § 4.1 also summarizes studies for Mexico, Africa, Asia and Europe, all of which show more extreme drought in the historical record than at present. None of these studies were cited by EPA, however. EPA's suggestion, therefore, that current drought conditions in the U.S. or elsewhere is evidence of anthropogenic climate change fails to account for a significant body of evidence to the contrary.

b. Storms.

EPA states that the Earth is experiencing increased storminess, particularly intense storminess, which it says is a reflection of the extreme weather events created by anthropogenic warming. But, as with EPA's discussion of increased drought, EPA's discussion of increased storminess lacks context in the historical record. As shown by Idso, § 4.5, many researchers have examined historical and proxy records in an attempt to determine how temperature changes over the past millennium or two have impacted this aspect of earth's climate. What they have found does not support the TSD's claims with respect to storms. As just a few examples reviewed by Idso:

- Dawson *et al*. (2002) searched daily meteorological records from Stornoway (Outer Hebrides), Lerwick (Shetland Islands), Wick (Caithness) and Fair Isle (west of the Shetland Islands) for all data pertaining to gale-force winds over the period 1876-1996, which they used to construct a history of storminess for that period for northern and northwestern Scotland. This history indicated that although North Atlantic storminess and associated wave heights increased over

the prior two decades, storminess in the North Atlantic region "was considerably more severe during parts of the nineteenth century than in recent decades."

- Bijl *et al*. (1999) analyzed long-term sea level records from several coastal stations in northwest Europe. According to these researchers, "although results show considerable natural variability on relatively short (decadal) time scales," there is "no sign of a significant increase in storminess ... over the complete time period of the data sets." In the southern portion of the North Sea, however, where natural variability was more moderate, they did find a trend, but it was "a tendency towards a weakening of the storm activity over the past 100 years."

- Pirazzoli (2000) analyzed tide-gauge, wind and atmospheric pressure data over the period 1951-1997 for the northern portion of the Atlantic coast of France. In that study, the number of atmospheric depressions (storms) and strong surge winds were found to be decreasing in frequency. In addition, it was reported that "ongoing trends of climate variability show a decrease in the frequency and hence the gravity of coastal flooding."

- In the United States, Zhang *et al*. (2000) used ten long-term records of storm surges derived from hourly tide gauge measurements to calculate annual values of the number, duration and integrated intensity of storms in eastern North America. Their analysis did not reveal any trends in storm activity during the twentieth century, which they say is suggestive of "a lack of response of storminess to minor global warming along the U.S. Atlantic coast during the last 100 yr."

- Noren *et al*. (2002) extracted sediment cores from thirteen small lakes distributed across a 20,000-km^2 region of Vermont and eastern New York, finding that "the frequency of storm-related floods in the northeastern United States has varied in regular cycles during the past 13,000 years (13 kyr), with a characteristic period of about 3 kyr." In addition, the most recent upswing in storminess did not begin with 20th century warming, but "at about 600 yr BP [Before Present], coincident with the beginning of the Little Ice Age." In reality, according to the authors, the increase in storminess was likely a product of natural changes in the Arctic Oscillation.

Furthermore, EPA did not cite Hanna *et al*. (2008), which found "there is little evidence that the mid-to late nineteenth century was less stormy than the present and there is no sign of a sustained enhanced storminess signal associated with "global warming." Similarly, EPA did not cite Matulla *et al*. (2007), which found no trends in daily wind strength (a measure of storminess) in Europe back to the late 19th century. Similarly, over a longer period and using a direct measure of storm intensity (frequency of low barometric pressure), Barring and von Storch

(2004), which is not cited by EPA, found no evidence of any systematic change in non-tropical storm intensity for over two centuries.

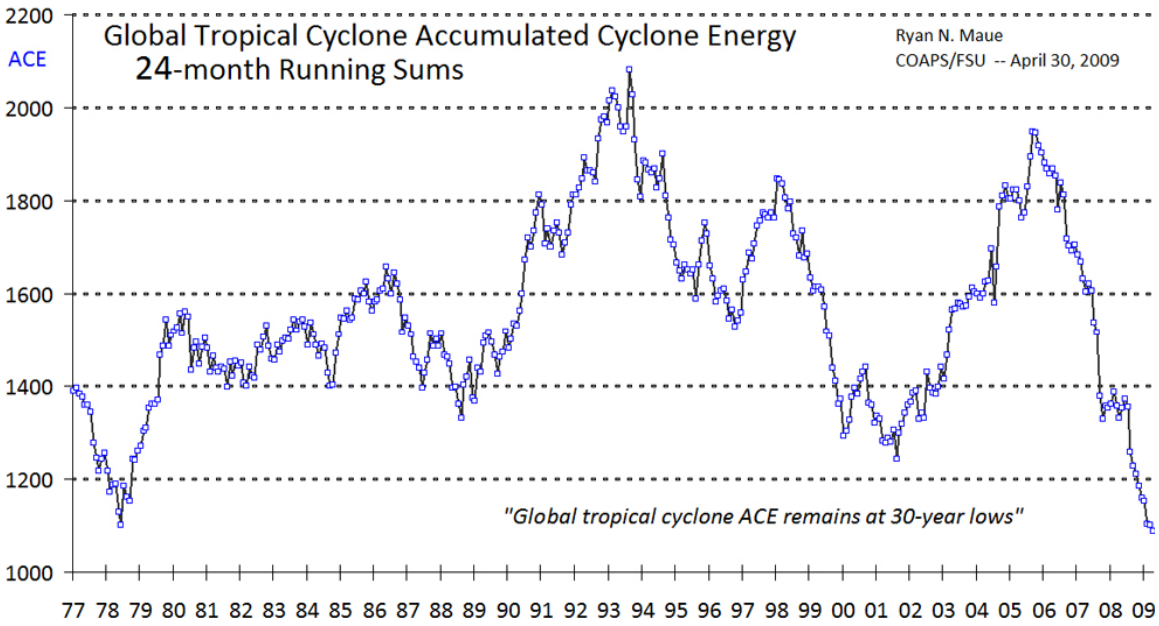
Taken together, a fair summation of the studies of past and current storminess is that, as the earth has warmed over the past hundred and fifty years, during its recovery from the global chill of the Little Ice Age, there has been no significant increase in either the frequency or intensity of stormy weather in Europe and North America. In fact, most studies suggest just the opposite has likely occurred.

c. Tropical Cyclones, Including Hurricanes.

The TSD states, "It is more likely than not that anthropogenic influence has contributed to increases in the frequency of the most intense tropical cyclones." TSD at 42. This statement fails to account for recent literature to the contrary.

EPA states that "[t]he power and frequency of *Atlantic hurricanes* have increased substantially *in recent decades*, though North American mainland land-falling hurricanes do not appear to have increased over the past century." TSD at 37 (emphasis supplied). On the other hand, the TSD states that "Kunkel *et al*. (2008) refer to a study that was not able to corroborate the presence of upward intensity trends over the last two decades in ocean basins other than the North Atlantic." TSD at 36. The TSD also notes that "Karl *et al*. (2008) indicate projections in frequency changes in tropical cyclones are too uncertain for confident prediction." *Id*. at 62.

EPA's reference to the lack of a trend in ocean basins other than the North Atlantic is confirmed by other studies. Further, ongoing monitoring of global tropical cyclone (tropical storm and hurricane) energy from Florida State University reveals (see Figure below) 1) no trend whatsoever, and 2) current values are at historically *low* levels (Maue, 2009).



Accumulated tropical cyclone energy history from Florida State University, 1977-present.

As to the North Atlantic Basin, EPA does not offer any reason as to why global warming would only increase activity in one of the world's five hurricane-prone regions. As found by Pielke Jr. *et al*. (2008), in a study not referenced by EPA, the escalating damages from recent hurricanes hitting the United States can be completely accounted for by demographic changes (and the changing value of the dollar), with no sign of any impacts of climate changes**.** If the power and frequency of Atlantic hurricanes were clearly increasing, then so would damages adjusted for population and property values.

Moreover, although EPA refers to an increase in North Atlantic hurricanes and hurricane-intensity "in recent decades," it fails to discuss Klotzbach and Gray (2006), which noted that "while major hurricane activity in the Atlantic has shown a large increase since 1995, global tropical-cyclone activity, as measured by the accumulated cyclone energy index, has decreased slightly during the past 16 years (Klotzbach, 2006)." As a result of these and other data and reasoning described in their paper, they "attribute the heightened Atlantic major hurricane activity of the 2004 season as well as the increased Atlantic major hurricane activity of the

previous nine years to be a consequence of multidecadal fluctuations in the strength of the Atlantic multidecadal mode and strength of the Atlantic Ocean thermohaline circulation." In this regard, for example, they say "historical records indicate that positive and negative phases of the Atlantic multidecadal mode and thermohaline circulation last about 25-30 years (typical period ~50-60 years; Gray *et al*., 1997; Latif *et al*., 2004)," and that "since we have been in this new active thermohaline circulation period for about 11 years, we can likely expect that most of the next 15-20 hurricane seasons will also be active, particularly with regard to increased major hurricane activity."

Indeed, many studies, published since the IPCC Fourth Assessment Report publication and ignored in the subsequent CCSP 2008i report and by EPA, describe an understanding of hurricanes and global warming that is different than that in the Endangerment Finding Proposal. Vecchi *et al*. (2008) summarize recent results, including Vecchi and Soden (2007a), presenting a picture of future Atlantic tropical cyclones that is not unlike that of today – with natural cycles dominating the patterns of variability. These new research results should temper the language on tropical cyclones (e.g. Knutson *et al*., 2008; Vecchi and Soden 2007a, 2007b; Vecchi *et al*., 2008). The first reference projects a change in intensity so small that it will likely not be detectable, but with a major reduction in the number of storms making landfall in the United States.

In fact, at this point, there are about as many recent refereed papers disputing the existence and/or magnitude of a trend in hurricane activity (e.g., Landsea, 2005; Landsea *et al*., 2006; Klotzbach, 2006; Landsea *et al*., 2006; Swanson, 2007, Landsea *et al*., 2009) as there are suggesting the existence of one. Further, new papers have been published showing that even if

an increasing trend does exist, it is not of the character as that projected by climate models to accompany anthropogenic GHG increases. Knutson *et al*. (2008) were quite explicit:

> Our results using the ensemble-mean global model projections are inconsistent with the notion of large, upward trends in tropical storm and hurricane frequency over the twentieth century, driven by greenhouse warming.

In fact, the topic of global warming and hurricane patterns is an active and fast-evolving field, and many of the most recent findings do not draw as close a linkage between anthropogenic climate changes and increasing hurricane frequency and/or intensity as those which served as the basis for the conclusions of the Endangerment Finding Proposal. These include, but are not limited to, the following studies not addressed by EPA:

- Briggs, W.M. (2008). On the changes in the number and intensity of North Atlantic tropical cyclones. *Journal of Climate*, *21*, 1387-1402.
- Knutson, T.R., *et al*., (2008). Simulated reduction in Atlantic hurricane frequency under twenty-first-century warming conditions. *Nature Geosciences*, doi:10.1038/ngeo202.
- Wang, C., & Lee, S.K. (2008). Global warming and United States landfalling hurricanes. *Geophysical Research Letters, 35*(1), L02708.
- Kossin, J.P., & Vimont, D.J. (2007). A more general framework for understanding Atlantic hurricane variability and trends. *Bulletin of the American Meteorological Society, 88*(11), 1767-1781.
- Landsea, C.W. (2007). Counting Atlantic tropical cyclones back to 1900. *EOS: Transactions of the American Geophysical Union, 88,* 197&203.
- Landsea, C.W., G. A. Vecchi, L. Bengtsson and T R. Knutson, 2009, Impact of duration thresholds on Atlantic tropical cyclone counts, Journal of Climate (submitted).
- Latif, M., Keenlyside, N., & Bader, J. (2007). Tropical sea surface temperature, vertical wind shear, and hurricane development. *Geophysical Research Letters, 34*(1), L01710.

- Nyberg, J., Malmgren, B.A., Winter, A., Jury, M.R., Kilbourne, K.H., & Quinn, T.M. (2007). Low hurricane activity in the 1970s and 1980s compared to the past 270 years. *Nature, 447*(7145), 698-701.

- Vecchi, G.A., & Soden, B.J. (2007). Effect of remote sea surface temperature change on potential tropical cyclone intensity. *Nature, 450*(7172), 1066-1070.

- Vecchi, G.A., & Soden, B.J. (2007). Increased tropical Atlantic wind shear in model projections of global warming. *Geophysical Research Letters, 34*(8), L08702.

- Vecchi, G. A., 2008. Whither Hurricane Activity? *Science*, **322**, 687-689.

Finally, as with EPA's observations on drought, EPA's observations on tropical cyclones lack context in the record of the current interglacial period. As shown in the studies cited by Idso, §§ 4.3.1.2, 4.2.1.3, 4.2.1.3.2 and 4.1.3.1.3.3, the current pattern of North Atlantic hurricanes is not unusual measured over the last few millennia, the last few centuries or the last century. Nor, over these time periods, is increased warming associated with increased hurricanes.

d. Floods.

The TSD appears to be in conflict as to whether there has been an increase in floods that would be a signal of anthropogenic warming. On the one hand, the TSD states that "... increases in heavy precipitation events have been linked to increases in flooding." TSD at 62. On the other hand, the TSD states that "... significant trends in floods and in evaporation and evapotranspiration have not been detected globally." TSD at 33. Both cannot be the case. In any event, EPA provides scant analysis of the issue and ignores the many studies, cited by Idso, § 4.2, showing no increase in floods as compared to the past.

5. EPA ignores studies showing that sea level rise has not accelerated.

The Executive Summary of the TSD states that "there is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate. It is not clear

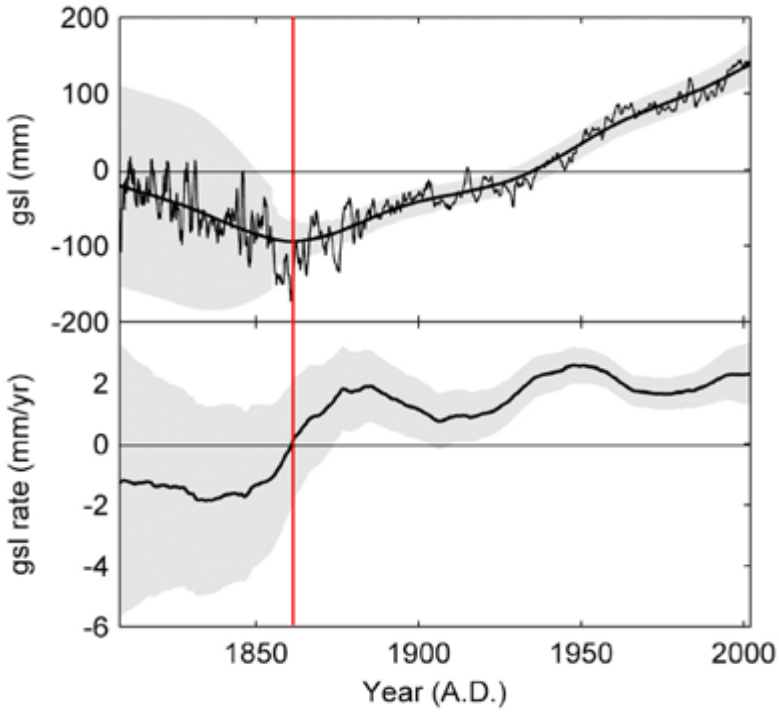
whether the increasing rate of sea level rise is a reflection of short-term variability or an increase in the longer-term trend." TSD at ES-2. It is hard to discern from this statement whether the TSD views sea level rise as a basis for its conclusion that anthropogenic GHG emissions are causing warming. In any event, EPA's discussion does not cite evidence that recent increases in sea level do not represent an acceleration of the underlying trend towards increasing sea levels and are merely a continuation of a trend that began well before the increase in atmospheric GHG concentrations. These studies are reviewed in Idso, § 3.7.

Thus, Wunsch *et al*. (2007), in a study not cited by EPA, write that "given the widespread and generally consistent reports of global warming, melting glaciers, shoreline retreat, and the clear trend of the last 20,000 years, a compelling inference is that global-mean sea level is rising," and in this regard they note that "the advent of high-accuracy satellite altimetry has led to estimates that, since about 1993, global average sea level has been rising at a rate of 2.8 ± 0.4 mm/year." They thus suggest "it is desirable to buttress [this finding] through independent means," which is what they set out to do.

"Using about 2.1 x 10^9 observations of many different types, all individually weighted, during the period 1992-2004 and a 1° horizontal resolution, 23-layer general circulation model," as the three researchers describe it, they derived estimates of "regional trends in global sea level." Results of their analyses produced "a global mean of about 1.6 mm/year, or about 60% of the pure altimetric estimate, of which about 70% is from the addition of freshwater." However, they note that there is "great regional variability in trend values, sometimes up to two orders of magnitude larger than the apparent spatial mean." In light of these findings, the three researchers state that "*at best, the determination and attribution of global-mean sea level change lies at the very edge of knowledge and technology,*" and that "*it remains possible that the*

database is insufficient to compute mean sea level trends with the accuracy necessary to discuss the impact of global warming – as disappointing as this conclusion may be." (Emphasis supplied.) As a result, they conclude that the altimetry result is "currently untestable against *in situ* datasets." Nevertheless, the mass of data they analyzed provided a result that was only 60% as large as that suggested by the satellite altimetry data, which has always been larger than results obtained from nearly all prior *in situ* studies.

Jevrejeva *et al*. (2006) analyzed information contained in the *Permanent Service for Mean Sea Level* database using a method based on Monte Carlo Singular Spectrum Analysis and removed 2- to 30-year quasi-periodic oscillations to derive nonlinear long-term trends for 12 large ocean regions, which they combined to produce the mean global sea level (gsl) and gsl rate-of-rise (gsl rate) curves depicted in the figure below.



Mean global sea level (top), with shaded 95% confidence interval, and mean gsl rate-of-rise (bottom), with shaded standard error interval, adapted from Jevrejeva et al. (2006).

In discussing their findings, Jevrejeva *et al*. say they show that "global sea level rise is irregular and varies greatly over time," noting that "it is apparent that rates in the 1920-1945 period are likely to be as large as today's." In addition, they report that their "global sea level trend estimate of 2.4 ± 1.0 mm/year for the period from 1993 to 2000 matches the 2.6 ± 0.7 mm/year sea level rise found from TOPEX/Poseidon altimeter data." However, with respect to what the four researchers describe as "the discussion on whether sea level rise is accelerating," their results demonstrate that it is not. As shown in the figure above, late 20th-century global warming is undetected in the global sea level data, while the effects of the warming that led to the demise of the Little Ice Age are *readily* apparent to the right of the vertical red line in the figure. Although the rising atmospheric CO_2 concentration experienced a dramatic increase in its rate-of-rise just after 1950 (shifting from a 1900-1950 mean rate-of-rise of 0.33 ppm/year to a 1950-2000 mean rate-of-rise of 1.17 ppm/year), the mean global sea level rate-of-rise did not trend upwards after 1950, nor has it subsequently exceeded its 1950 rate-of-rise.

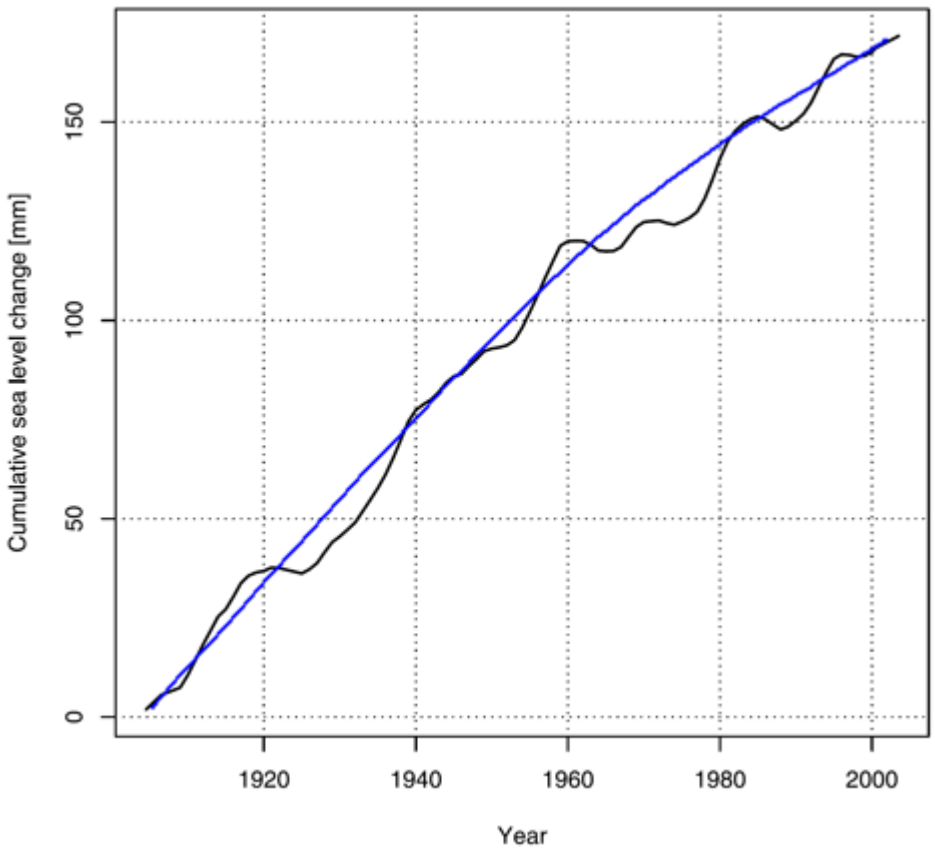
Holgate and Woodworth (2004) derived a mean global sea level history from 177 coastal tide gauge records that spanned the period 1955-1998; and in an attempt to extend that record back in time another half-century, Holgate (2007) chose nine much longer high-quality records from around the world (New York, Key West, San Diego, Balboa, Honolulu, Cascais, Newlyn, Trieste and Auckland) to see if their combined mean progression over the 1955-1998 period was similar enough to the concomitant mean sea level history of the 177 stations to employ the mean nine-station record as a reasonable representation of mean global sea level history for the much longer period stretching from 1904 to 2003.

In comparing the sea level histories derived from the two data sets, Holgate found that their mean rates-of-rise were indeed similar over the second half of the 20th century; and this

observation thus implied, in Holgate's words, that "a few high quality records from around the world can be used to examine large spatial-scale decadal variability as well as many gauges from each region are able to [do]."

As a result of this finding, Holgate constructed the nine-station-derived wavering black line in the figure below as a reasonable best representation of the 1904-2003 mean global sea level history of the world, and based on that history calculated that the mean rate of global sea level rise was "larger in the early part of the last century (2.03 ± 0.35 mm/year 1904-1953), in comparison with the latter part (1.45 ± 0.34 mm/year 1954-2003)."

Another way of thinking about the century-long sea level history portrayed in the figure below is suggested by the blue curve fit to it, which indicates that mean global sea level may have been rising, in the mean, ever more slowly with the passage of time throughout the entire last hundred years, with a possible acceleration of that trend over the last few decades.



Cumulative increase in mean global sea level (1904-2003) derived from nine high-quality tide gauge records from around the world. Adapted from Holgate (2007).

In any event, and whichever way the findings of Holgate are interpreted – either as two successive linear trends (representative of the mean rates-of-rise of the first and last halves of the 20th Century) or as one longer continuous curve (such as presented in the figure above) – the nine select tide gauge records indicate that the mean rate of global sea level rise has not accelerated over the recent past.

Whereas most previous attempts to calculate rates of global sea level rise (GSLR) "coped with the problem of interannual and decadal scale variability by averaging large or long-term data sets," Kolker and Hameed (2007) note that an alternative approach is to "determine the cause of this variability." And since GSLR variability has been linked to storms, winds, floods, Rossby waves, shifts in major ocean currents, volcanically-induced ocean heat content

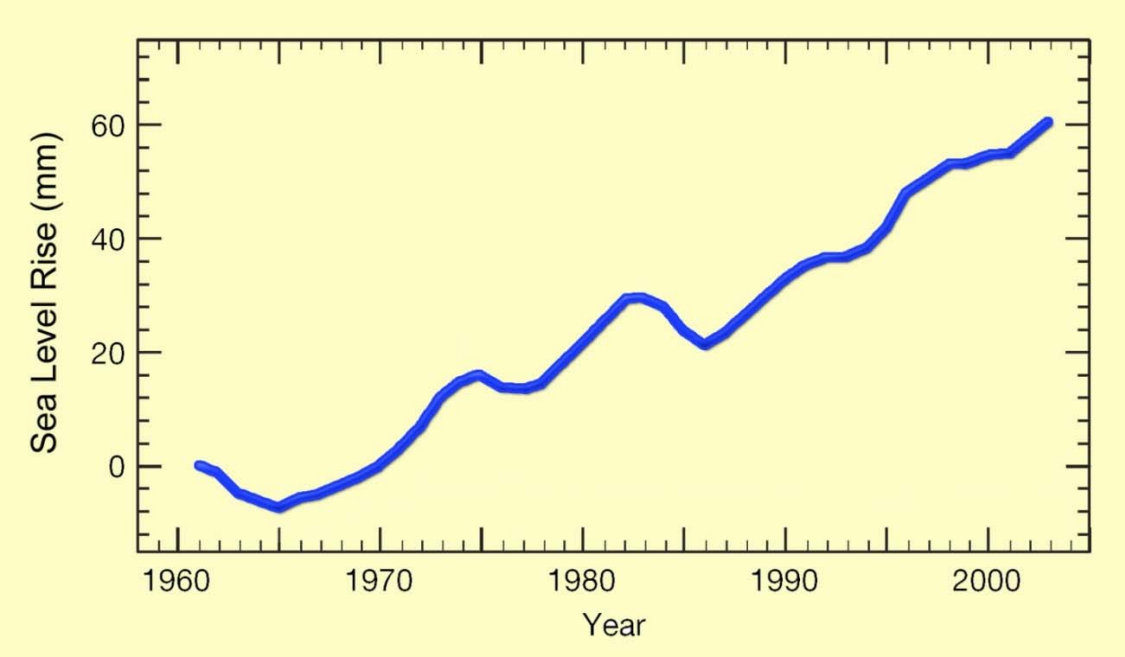
variations, and the El Niño Southern Oscillation – with further regional complications introduced by subsidence, uplift, tectonics, freshwater fluxes and thermosteric effects – they attempt to resolve this problem by showing that "a major fraction of the variability and the trend in mean sea level at key sites along the Atlantic Ocean are driven by shifts in the position and intensity of the major atmospheric pressure centers that reside over the Atlantic Ocean, the Azores High and the Icelandic Low," which they refer to as atmospheric *centers of action* (COAs).

Results of their analysis indicated that "a large fraction of the annual mean sea-level variability at the five Atlantic Ocean stations is correlated with shifts in the position and intensity of the COAs," which suggests that "meteorological processes drive coastal sea-level variability by redistributing water, heat, and the response of the ocean to atmospheric pressure across the ocean basin." Utilizing this knowledge, and depending on what assumptions they employed at various stages of their analyses, the authors obtained four sets of 20th-century mean rates of sea-level rise for the entire North Atlantic Ocean: 0.49 ± 0.25 mm/year, 0.59 ± 0.14 mm/year, 0.72 ± 0.33 mm/year and 0.93 ± 0.39 mm/year.

In recognizing that their results "yield rates of recent sea level rise that are closer to Wadhams and Munk's 1.1 mm/year than Miller and Douglas's 1.5-2.0 mm/year," Kolker and Hameed suggest that their findings could close what they call "the enigmatic gap in GSLR rates" if their results are characteristic of other major ocean basins, which they probably are, as they note that "atmospheric centers of action exist in all ocean basins." If such eventually proves to be the case, the lower GSLR rates derived by them and Wadhams and Munk would be much less than the 3.1 ± 0.7 mm/year GSLR rate of the IPCC Fourth Assessment Report.

More recently, Domingues *et al*. (2008) derived "improved estimates of near-global ocean heat content and thermal expansion for the upper 300 meters and 700 meters of the ocean

for 1950-2003, using statistical techniques that allow for sparse data coverage and applying recent corrections to reduce systematic biases in the most common ocean temperature observations." In describing their results, the seven scientists say they "show a slight increase from 1950 to about 1960, a 15-year period to the mid-1970s of zero, or slightly negative trend and, after the 1976-1977 climate shift, a steady rise to the end of the record," noting that their "ocean warming and thermal expansion trends for 1961-2003 are about 50 percent larger than earlier estimates but about 40 percent smaller for 1993-2003, which is consistent with the recognition that previously estimated rates for the 1990s had a positive bias as a result of instrumental errors." In addition, when they add their observational estimate of upper-ocean thermal expansion to other contributions to sea-level rise (thermal expansion in the deep ocean, the ice sheets of Antarctica and Greenland, glaciers and ice caps, and terrestrial storage), they find that "the sum of contributions from 1961 to 2003 is about 1.5 ± 0.4 mm/year," (see the figure below) which they note is "in good agreement with [their] updated estimate of near-global mean sea-level rise (using techniques established in earlier studies) of 1.6 ± 0.42 mm/year."



Estimate of total observed sea level rise since 1961. Adapted from Domingues et al. (2008).

Woppelmann *et al*. (2007) described a technique they developed for utilizing Global Positioning System (GPS) data, which they obtained from numerous GPS stations situated in close proximity to various tide gauges around the world, to correct the tide gauge records and thus obtain what they call a "set of 'absolute' or geocentric sea-level trends." Based on a number of criteria that had to be met by both the tide gauge and GPS stations, they ultimately used paired data sets from 28 locations that covered a time span of 5.9 years (1999.0-2005.7) to derive their final mean global result, after which they compared it with what they call the "most quoted" tide-gauge results of Douglas (1991, 1997, 2001), which had been corrected for the most common form of vertical land motion by means of theoretical *models* of Glacial-Isostatic Adjustment (GIA).

Results of the comparison indicated that whereas the data of Douglas yielded a mean global sea-level rate-of-rise of 1.84 ± 0.35 mm/year after correction for the GIA effect (Peltier,

2001), Woppelmann *et al*. obtained a much lower mean value of 1.35 ± 0.34 mm/year when employing their correction for measured GPS vertical velocities. The sizable difference between these two results raises the question of how they compare with results obtained from other ways of estimating global sea level trends. In this regard, the four researchers note that Mitrovica *et al*. (2006) recently indicated there is a 1 mm/year contribution to sea-level rise from the melting of global land ice reservoirs, as well as a 0.4 mm/year contribution from thermal expansion of the global ocean. Antonov *et al*., 2005. Together, these two numbers yield a value of 1.40 mm/year for the global ocean's total sea-level mean rate-of-rise, which is much closer to the 1.35 mm/year result of Woppelmann *et al*. than to the Douglas-Peltier result of 1.84 mm/year.

In sum, recent scientific literature calls into question EPA's conclusion that sea level rise is accelerating.

6. EPA ignores studies showing that natural forces correlate better with recent climate than increased atmospheric GHG concentrations.

EPA concludes that "most of the warming cannot be explained by natural variability, such as variations in solar activity." EF at 18896/2. Expounding somewhat on this conclusion, the TSD compares the direct radiative forcing effect resulting from changes in solar output since 1750 to an approximation of the net forcing due to anthropogenic influence over the same time period, and finds that the latter is responsible for an order of magnitude more warming effect than the former. TSD at 20. Based on this comparison and model simulations, the TSD states that "[c]limate model simulations *suggest* natural forcing alone (e.g. changes in solar irradiance) *cannot* explain the observed warming [of global average temperatures]." TSD at ES-2, 40 (emphasis added).

However, in reaching its conclusion, the TSD ignores or otherwise fails to address numerous significant peer-reviewed studies that in fact point to a solar-climate link, and

conclude that solar variations, as opposed to human activities, are the primary catalyst for climate change, both historical and future. Idso, § 2.3 presents the findings of various scientists exploring this solar-climate link and the role of cosmic ray and cloud cover variations as a potential mechanism for the translation of small changes in solar activity into more substantial climate effects.

For example, in a 2007 study, Svensmark demonstrates that electrons released by cosmic rays encourage the formation of cloud condensation nuclei. His findings also showed that, where solar magnetic activity is higher, the earth is more shielded from the penetration of cosmic rays to the lower atmosphere, which in turn results in the formation of fewer and less reflective low-level clouds. With less low-level cloud cover, more solar radiation is absorbed by earth's surface, and the end result is global warming. Svensmark's research indicates that not only is there a solar-climate connection, but the amplifying mechanism by which solar variations affect near-surface air temperatures may be galactic cosmic rays, as affected by solar magnetic activity in the manner described above.

Notably, the work of Bond, *et al*. (2001) linked millenial-scale climate oscillations with oscillations in solar activity. The researchers reported that "over the last 12,000 years virtually every centennial time-scale increase in drift ice documented in our North Atlantic records was tied to a solar minimum," and confirmatory studies undertaken in various locations from the polar to the tropical latitudes suggest that the same cyclical climatic-solar effects are experienced throughout the world. Moreover, solar variability has been linked to weather-related natural phenomena worldwide, such as floods, droughts, precipitation, streamflow, and monsoons.

Correlations between solar irradiance, or brightness, and solar magnetic activity have also been demonstrated. *See, e.g.* Parker (1999). Because increased brightness is, in turn, known to

influence sea surface temperatures, such studies evidence a link between solar magnetic activity and global temperatures that is arguably closer than the relationship between CO2 and temperature.

D. EPA's Discussion of the Effect of Climate Change on the Public Health and Welfare Lacks Context.

The TSD's discussion of health and welfare effects is heavily biased towards extreme scenarios and ignores three fundamental points. First, EPA fails to examine studies showing the likelihood that the GCMs overestimate the sensitivity of the climate to increasing GHG emissions. Second, EPA fails to account for the ability of the United States to adapt to climate change. Third, EPA ignores numerous studies showing that many of the specific health and welfare effects which it relies on are not the result of anthropogenic warming. Although our discussion below is more brief, these points are examined in detail in Michaels at 50-52 and Idso at § 8.1. Both of these papers discuss each health and welfare effect cited by EPA and discuss literature undermining EPA's conclusions.

1. All of EPA's conclusions as to future deleterious climate effects are based on model assumptions as to the sensitivity of the climate to a doubling of CO2, and EPA ignores evidence that these assumptions may be wrong.

EPA concludes that future climate change will produce a variety of negative effects on the health and welfare of the U.S. population. EPA's conclusions in this regard are dependent on the validity of EPA's projections of future warming, and specifically model predictions that the climate response to a doubling of CO_2 will be in the range of 2.0 to 4.5°C, with the most likely value of 3.0°C. As just one example, the TSD states that "*[a]s a result of the projected warming,* the IPCC projects increases in heat-related mortality and morbidity globally (IPCC, 2007b)." TSD at 70 (emphasis supplied).

EPA's discussion of future health and welfare effects, however, ignores the studies, discussed extensively in Section B above, indicating that temperatures are rising far more slowly than predicted by the models, indicating a climate sensitivity at or below the low end of the range projected by IPCC. As discussed in Michaels at 5, the true likely value is highly dependent upon how much one ascribes the (0.5°C) warming of the early 20th century to carbon dioxide. It is generally thought that much of the early 20th century warming was largely driven by natural variations including changes of the sun's output. If that is true, then the equilibrium warming for a doubling is quite low, as only the warming from 1976-1998 could arguably be ascribed largely to carbon dioxide (there has been no warming since 1998). Given a combination of residence time and equilibration time in the range of 60 years (still a reasonable assumption), and the linearities of the midrange SRES (and other) scenarios, this points towards a warming of about 1.6°C in this century, which roughly translates to an equilibrium sensitivity of a doubling to around 2.1°C. And since, as demonstrated in Section II.B above, the amount and rate of warming in the last 50 years may be overstated by the IPCC and may also be attributable in large measure to natural causes, the climate sensitivity to a doubling of CO_2 is likely to be lower still.

Evidence for a climate sensitivity lying closer to the lower end of the IPCC range has also been presented by recent results in the scientific literature – results which were not included in the material relied upon by the Endangerment Finding Proposal. Chylek and Lohmann (2008) examined ice core records from the transition from the Last Glacial Maximum to derive a 95% confidence range for the climate sensitivity of between 1.3ºC and 2.3ºC for a CO_2 doubling. Wyant *et al*. (2006) reported than when better cloud processes are incorporated into climate models (an area where models are notoriously deficient), the climate sensitivity declines to value at or below the low end of the IPCC range. Similar conclusions indicating that observed (rather

than modeled) cloudcover changes (and their impact on atmospheric moisture content) suggest a lower climate sensitivity than IPCC estimates have been made by Spencer *et al*. (2007), Spencer and Braswell (2008), and Paltridge *et al*. (2009). Other observational evidence supporting a low climate sensitivity value is included in work by Swanson and Tsonis (2009) and Michaels *et al*. (2009).

That the real world climate sensitivity is lower than climate model determinations of this quantity signifies that future projections from these climate models are over-estimates of the potential climate changes resulting from enhanced atmospheric greenhouse gas levels. If the changes to the future climate are overestimates, so too are the estimates of the potential impacts resulting from climate change.

This creates a particular problem for the validity of EPA's conclusions as to whether potential future warming will create meaningful health and welfare impacts within the United States, the area of concern for EPA's analysis. For instance, EPA quotes the CCSP as follows:

> The more recent CCSP (2008b) report on human health stated as one of its conclusions that, "The United States is certainly capable of adapting to the collective impacts of climate change. However, there will still be certain individuals and locations where the adaptive capacity is less and these individuals and their communities will be disproportionately impacted by climate change."

TSD at 69.

If, however, the climate sensitivity is less than EPA projects, then even the "certain individuals ande locations" to which EPA refers may be readily able to take measures to mitigate any climate change effects. The issue must at least be discussed by EPA.

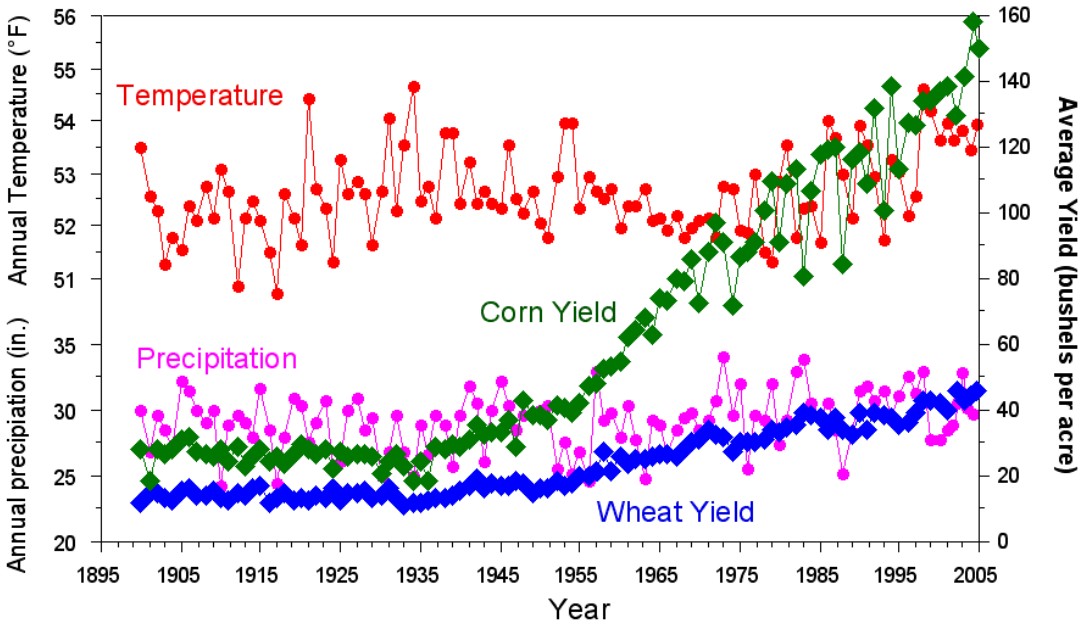
2. EPA ignores adaptation.

Despite referencing the CCSP's view that many in the United States will not be able to adapt to climate change, EPA generally disregards the ability of the United States to prevent negative health and welfare climate impacts through adaptation, arguing that the possible necessity to adapt is itself proof of deleterious climate change. EPA's argument, however, is illogical.

First, the Agency's projections of future climate change are based on very long-term emissions scenarios that, in turn, are based on very long-term projections of future economic activity. Economic activity therefore cannot be separated from climate change and climate impacts. How people behave in an economic setting will equally determine both the extent of any human-induced climate change and whether people are harmed by such climate change. The two issues cannot be separated.

Moreover, regardless of whether climate change has an anthropogenic component, people adapt to climate in the normal course of their daily lives. Indeed, the trend in the United States has been for people to move to warmer locations and to coastal locations despite the threat of hurricanes. Nevertheless, health and welfare continue to improve with improving technology.

EPA's failure to consider adaptation undermines virtually all of its analysis of the negative health effects of climate change. The Michaels paper at 50-55, 61-65 discusses this in detail. One example will suffice here. EPA views climate change as a particular danger for agriculture, TSD, Ch. 9, but fails to discuss the fact that agricultural productivity has increased even as EPA says the climate has warmed.



Yields of major cash crops such as corn and wheat show annual fluctuations as a result of weather conditions, but overall, they exhibit an upwards trends that far exceeds climate changes (data sources: NCDC, USDA).

Of course, climate change could be so extreme that agriculture could not adapt. The same could be the case for many of the other health and welfare effects discussed by EPA. But, as noted in the previous section of these comments, if EPA believes that only the extreme scenarios are likely, it must discuss the considerable science we have cited here to the contrary. As to the non-extreme scenarios, EPA cannot reasonably discount the ability of the United States to adapt, as it has to the constantly changing climate of the past.

3. EPA fails to discuss evidence that detrimental health effects in the United States are unlikely at any but the more extreme rates of warming.

EPA's conclusion that anthropogenic GHG emissions will endanger human health in the United States fails to discuss a significant body of literature to the contrary, as set forth in Idso at Ch. 8 and Michaels. We discuss two of the principal health issues, mortality and disease, below.

a. Mortality.

The Endangerment Finding Proposal concludes that increases in morbidity and mortality are "likely" due to an expected increase in the magnitude and duration of severe heat waves in the United States. EF at 18901/2. EPA also acknowledges, however, that warmer temperatures may also be expected to result in certain health benefits, including a reduction in cold-related deaths, and that "it is currently difficult to ascertain the balance between increased heat-related mortality and decreased cold-related mortality." EF at 18901/2; TSD at 70. While EPA does not attempt to quantify the various effects on mortality and morbidity due to climate change, the Endangerment Finding Proposal nevertheless concludes that "on balance," the risks from "unusually hot days and nights" as well as those from heat waves, "support a finding that human health is endangered even if it is also possible that modest temperature increases will have some beneficial health effects." EF at 18901/2.

These findings fail to adequately consider numerous scientific studies that have shown, in various parts of the world including the United States, that global warming is in fact likely to produce the opposite result: a reduction in the number of lives lost due to extreme thermal conditions. For example, the work of numerous researchers shows that mortality rates increase as temperatures fall, but as temperatures rise, no clear trend emerges: mortality rates do not necessarily rise. Keatinge and Donaldson (2001), Keatinge *et al*. (2000), Gouveia *et al*. (2003)). In fact, in various regions of the world, cold-related deaths were almost ten times greater than heat-related deaths over the same time period. Keatinge *et al*. (2000). In the United States specifically, deaths due to extreme cold were greater than those attributable to extreme heat by 80% to 125%. Goklany and Straja (2000).

A key factor affecting the projected impact of global warming on morbidity and mortality is effective adaptation. Studies that show a positive relationship between mortality and

increasing temperatures tend to fail to consider the ability of human populations to adapt to temperature changes. In fact, in its discussion of the subject, the TSD does not even mention adaptation to frequent heat waves. Given the number of peer-reviewed studies on adaptation to thermal extremes, this oversight significantly impairs the scientific integrity of the TSD on this topic.

Recent U.S. studies have demonstrated that increasing summer heat does not, in the long run, increase human mortality. Davis *et al*. (2003a, b). In fact, heat wave deaths have been shown to decline as the frequency of heat waves increases. Davis *et al*. (2003a, b). And, over the course of a single heat wave, studies have found that "the longer the 'run' the fewer the deaths," whereas the opposite is true during a period of extreme cold. Bull and Morton (1978). Numerous studies by Davis *et al*. show that "the population's sensitivity to extreme heat has been declining across the U.S. from the 1960s through the 1990s" despite rising summertime temperatures. Michaels at 67. These findings are supported by the work of Dr. Robert Mendelsohn, who argues that "heat-stress deaths are caused by temperature variability and not warming," and are particularly likely where sudden heat waves occur in areas in which the population has not yet adapted. Michaels at 28-29.

As such, it appears that the human population is able to rapidly adapt to changes in thermal conditions, and in fact already has. The issue is discussed further at Idso, § 8.1.

b. Disease.

The TSD cites as "likely" climate change health effects in North America: "[i]ncreased deaths, injuries, infectious diseases, and stress-related disorders and other adverse effects associated with social disruption and migration from more frequent extreme weather" and "[e]xpanded ranges of vector-borne and tick-borne diseases." TSD at 69. According to the TSD,

"many human diseases are sensitive to weather," as evidenced by the seasonal incidence trends of many airborne and waterborne diseases, and studies suggesting temperature-related increases in the transmission of diseases such as West Nile virus. *Id*. at 72-73. The TSD does acknowledge that "human health risks from climate change will be *strongly modulated* by changes in health care, infrastructure, technology, and accessibility to health care" as well as the dynamics of population aging and immigration/emigration patterns. *Id*. at 73 (emphasis added). Nevertheless, the TSD concludes that: "[d]epending on progress in health care and access, infrastructure, and technology, climate change *could* increase the risk of heat wave deaths, respiratory illness through exposure to aeroallergens and ozone . . . and certain diseases." *Id.* at 69 (emphasis added).

The TSD fails to address numerous studies that demonstrate that a variety of human diseases are actually exacerbated by colder temperatures and high variability, not a generally warmer climate. For example, scientists studying cardiovascular disease in the U.S. specifically have concluded that coronary deaths are 30%-40% higher in winter months than during the summer. (loner *et al*. (1999). Additionally, a comparison of "hot" and "cold" U.S. cities analyzed both the acute effects and lagged influence of temperature on cardiovascular-related deaths, and found that, in the cold cities, death rates were affected by both high and low temperatures, but that the cold temperature effects were felt for days while the high temperature effects were limited to the single high temperature day and perhaps the day immediately preceding the heat event. (raga *et al*. (2002). In the hot cities, neither temperature extreme had a demonstrable effect on cardiovascular-related death rates. Braga *et al*. (2002).

With respect to respiratory-related diseases, Braga's study showed that temperature variability is a key factor, and other studies have show that temperature variability, in general,

declines substantially with warming. Robeson (2002). So there, too, disease rates and severity can be expected to actually decrease in a warmer climate. These findings are consistent with other studies focusing on temperature-related trends in other parts of the world.

The TSD's conclusion that vector-borne diseases will increase as a result of a warmer climate also overstates the potential implications of warming on such diseases, while undervaluing the effect of mitigative measures. In fact, the studies cited in the TSD fail to conclusively establish a link between climate and the U.S. incidence of the specific vector- and tick-borne diseases cited. Rather, the introduction and spread of West Nile virus in the United States progressed southward and westward in a manner unrelated to climate or temperature. Michaels at 56-58. Temperature has also not been shown to drive St. Louis encephalitis outbreaks. Michaels at 58-59.

Moreover, studies that were ignored by the TSD have shown that ranges of tick-borne and vector-borne diseases may not necessarily expand due to global warming and in fact that warmer temperatures may disrupt conditions necessary for transmission and reproduction, resulting in a decrease in such vector-borne illnesses. Randolph and Rogers (2000). With respect to malaria specifically, numerous scientists have emphasized the complexity of the disease, and conclude that studies examining the impact of one variable – temperature – over-simplify the potential impact of temperature changes on the spread and severity of the disease. Reiter (2000); Rogers and Randolph (2000).

Even if an increase in temperatures does intensify the incidence of disease in the U.S., changes in disease biology may be mitigated or even outweighed by modifications in public health practices and lifestyle. Zell (2004); Michaels at 60-61. A further discussion of literature not cited by the TSD is set forth in Idso, § 8.1.

E. EPA Ignores and Overwhelming Body of Literature Showing That Rising Atmospheric CO2 Will Benefit Plant Life.

A tremendous body of literature – literally hundreds of studies not discussed by EPA – demonstrates the positive effect of increased CO_2 on plant life. These studies are discussed in Idso, Chs. 5 and 6. Contrary to EPA's conclusions, these benefits occur across a wide variety of species and enhance, rather than retard, a plant's ability to withstand increased temperatures and reduced water availability.

Critically, the CO_2-fertilization effect will enhance crop productivity. As Idso shows, increased levels of CO_2 have a positive effect on the productivity of major crops grown for food across the world, including maize, peanuts, potatoes, rice, sorghum, soybeans, tomatoes, and wheat. Positive productivity effects were also found for other important agricultural crops, including alfalfa, cotton, and sunflowers. Other positive effects included better water use efficiency, amelioration of environmental stresses, acclimation, resistance to competition and respiration. Benefits were also found for a variety of woody plants, including fruit-bearing trees. EPA.

According to the United Nations, perhaps the most pressing health and welfare issue in the world today is the need for a second green revolution to feed the ever-increasing world population without using ecologically sensitive land for agriculture. The United Nations has called for a doubling of food production by 2030 in order to meet rising demand. *See* http://news.bbc.co.uk/2/hi/in_depth/7432583.stm. In this light, EPA's failure to provide a balanced discussion of the health and welfare effects of increasing carbon fertilization undermines the validity of the Agency's overall endangerment conclusions.

III. CONCLUSION

EPA does not present a complete analysis of climate change literature. In particular, EPA fails to cite a large number of peer-reviewed journal articles and other scientific evidence conflicting with many of EPA's conclusions. EPA's analysis, therefore, at this point, is arbitrary and capricious, in conflict with the Information Quality Act, and a failure by the Administrator to exercise her own judgment under Section 202(a). We urge the Agency to closely consider the science we cite here. If EPA continues to believe an endangerment finding is warranted, EPA should issue a new proposal providing a more comprehensive analysis in support of that conclusion.